American Institute of Professional Geologists
45th Annual Meeting

Arizona Hydrological Society
21st Annual Symposium

3rd International Professional Geology Conference

Association of Earth Science Editors Annual Meeting
AIPG – AHS – 3rd IPGC 2008 Symposium

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Welcome and Acknowledgments

On behalf of the Arizona Section of the American Institute of Professional Geologists (AIPG) and the Arizona Hydrological Society (AHS), I am pleased to welcome you to AIPG’s 45th Annual Meeting, AHS’s 21st Annual Symposium, and the 3rd International Professional Geology Conference (3rd IPGC) in Flagstaff, Arizona. This meeting has been a collaborative effort between the professional organizations. The organizing committee is co-chaired by Dr. David Best, Professor of Geology at Northern Arizona University (NAU), for AIPG and Dr. Aregai Tecle, Professor of Hydrology at NAU, for AHS. Dr. Robert Font, for AIPG, is the chairman of the 3rd IPGC. I appreciate their assistance in planning so many aspects of this conference. I also want to thank Margot Truini for heading up the technical sessions and overseeing the audio-visual aspects for the technical sessions, Erin Young for her efforts in developing the workshops and coordinating student volunteers, David Palmer for heading up the field trips program and completion of the field trip guidebooks, Virginia McLemore for editing and development of the Proceedings of the conference, Pam Palmer for her efforts in planning a wonderful guest trip program, Boris Poff for assisting in developing the technical sessions program, Kel Buchanan for heading up the sponsorship and exhibitors committee, Bill Greenslade, Mike Hulst, and David Kirchner for assisting with sponsors/exhibitors, Dana Downs-Heimes and Charles Schlinger for miscellaneous program assistance, and Bill Siok, Alan Dulaney and Mike Geddis for general oversight and marketing of the conference. I also want to particularly thank AIPG’s headquarters staff Cathy Duran, Wendy Davidson, Cristie Valero, and Emma Schlundt who spent many hours with the day-to-day logistics of planning and organizing this conference.

The world of geoscientists is a diverse community of professionals who work to discover and develop the resources needed to sustain and enhance life and contribute to each nation’s economy, environment, public health and welfare. Exploration and responsible development of energy and mineral resources, and water resources are a few of the many contributions made by geoscientists. The many roles of geoscientists led to the development of the theme for this conference: Changing Waterscapes and Water Ethics for the 21st Century and the 3rd IPGC theme of Global Geoscience Practice, Standards, Ethics, and Accountability. This conference includes a broad range of topics for the presentations of technical talks and poster sessions. The topics include: aquifer recharge and restoration, groundwater issues and ethics, forest watershed management, water quality, human vs. ecosystem needs, land subsidence, professional ethics, Southwest water policy issues, surface water – groundwater issues, modeling, tribal water practices, urban and rural water policies and practices, GIS and water resources, water use and water quality of mining operations, and water supply vs. public policy. The concurrent 3rd IPGC technical sessions include: Training, Credentials, and Continuing Professional Development of the Global Professional Geoscientist, Professional Ethics and the Global Geoscientist and Expanding International Influence and Reach; Overcoming Challenges and Mapping Successful Strategies. As you review this program I think you will be impressed by the quality and variety of presentations.

We have planned an exciting meeting with two days of technical sessions, several pre- and post- conference informative and instructional workshops, and several days with field trip opportunities to explore the geology and enjoy the scenery of northern Arizona. The welcoming reception and technical sessions will be held at the new High Country Conference Center on the campus of NAU in the city of Flagstaff. This state-of-the-art facility offers spacious meeting rooms and reception areas with spectacular views of the San Francisco Peaks. The field trips include the Grand Canyon, Fossil Creek, Flagstaff area, Walnut Canyon and Lake Mary, the red rocks of Sedona, Jerome mining district, Montezuma’s Castle and Well, Meteor Crater, Sunset Crater and Wupatki. And, we have planned several social functions featuring southwestern entertainment at the Radisson Hotel, at the High Country Conference Center, and at the Museum of Northern Arizona.

So, welcome to Flagstaff, Arizona, for AIPG’s 45th Annual Meeting, AHS’s 21st Annual Symposium, and the 3rd International Professional Geology Conference!!!!

Barbara H. Murphy RG, CPG-06203
AIPG Arizona Section President 2008
General Chairperson AIPG/AHS/3rd IPGC Conference
Welcome to the Third International Professional Geology Conference (3IPGC)!

I echo Barbara Murphy’s welcome to Flagstaff and to the Third International Professional Geology Conference (3IPGC)!

The AIPG is delighted to have the opportunity to organize and co-host this important meeting and is honored to have your countries, your organizations and your representatives as part of the exciting venue. We also welcome the opportunity to give you a taste of the American West and to showcase some of our breathtaking geological features. The IPGC forums are used to outline issues affecting the geological profession and professional practice across domestic and international boundaries. The IPGC meetings are also opportunities to exchange ideas on how to solve geoscience-related problems at both regional and global scales.

In regards to the 3IPGC, we certainly hope to follow in the tradition of excellence set forth during our previous two meetings, in Spain and the UK, where our local hosts (El Ilustre Colegio Oficial de Geólogos de España and The Geological Society of London) performed so admirably. We have selected a truly outstanding geological location to hold this convention. We have worked hard to make the 3IPGC an up-to-the-minute professional gathering with expanded international and domestic participation.

This year, a special effort has been made to have representatives from as many different disciplines as possible within the field of the geosciences in order to address a variety of professional issues of importance to all. Topics of discussion include:

- Training, Credentials and Continuing Professional Development of the Global Professional Geoscientist
- Professional Ethics and the Global Geoscientist; New Horizons in Geology
- Expanding International Influence and Reach; Overcoming Challenges and Mapping Successful Strategies

Much effort has gone into preparing this conference. I especially want to thank General Chairman Barbara Murphy, AIPG headquarters staff (specifically Cathy Duran, Director Bill Siok and Assistant Director Wendy Davidson), the Arizona Section of AIPG, Northern Arizona University and all others who worked so hard to make this happen! In addition, I wish to recognize all the organizations that are co-hosting the 3IPGC. The American Institute of Professional Geologists, The European Federation of Geologists and The Canadian Council of Professional Geoscientists have always been the perennial co-hosts of the IPGCs. This year we are honored to have additional prominent co-hosts, including the following groups:

- The National Association of State Boards of Geology
- The Division of Professional Affairs of the American Association of Petroleum Geologists
- The Association of Women Geoscientists
- The Arizona Hydrological Society
- Northern Arizona University
- International Year of Planet Earth
- The Association of Environmental and Engineering Geologists
- The Geological Society of America
- The United States Geological Survey
- The Association of Earth Science Editors
- The American Geological Institute

We are delighted to have you in Flagstaff and will do all within our power to make this a memorable experience for you! We are certainly honored with your presence!

Robert Font, CPG-03953
3rd IPGC Chairman
2005 AIPG National President
Forward

This Program includes abstracts for the oral presentations and posters scheduled for presentation at the technical sessions on September 22nd and 23rd, 2008 at the American Institute of Professional Geologists (AIPG) 45th Annual Meeting, the Arizona Hydrological Society (AHS) 21st Annual Symposium, and the 3rd International Professional Geology Conference (3rd IPGC), held in Flagstaff, Arizona.

The papers presented represent the broad theme for this conference: Changing Waterscapes and Water Ethics for the 21st Century and the 3rd IPGC theme of Global Geoscience Practice, Standards, Ethics, and Accountability. The technical sessions topics include: aquifer recharge and restoration, groundwater issues and ethics, forest watershed management, water quality, human vs. ecosystem needs, land subsidence, professional ethics, Southwest water policy issues, surface water – groundwater issues, modeling, tribal water practices, urban and rural water policies and practices, GIS and water resources, water use and water quality of mining operations, and water supply vs. public policy. The concurrent 3rd IPGC technical sessions include: Training, Credentials, and Continuing Professional Development of the Global Professional Geoscientist, Professional Ethics and the Global Geoscientist and Expanding International Influence and Reach; Overcoming Challenges and Mapping Successful Strategies.

The Program also lists the schedule and presenters for the technical sessions, the moderators of those sessions, and the room location at the High Country Conference Center. The Opening Remarks and Plenary session will be held in Prochnow Auditorium, located just to the south of the High Country Conference Center on the campus of Northern Arizona University.

As you review this program I think you will be impressed by the quality and variety of presentations. The abstracts are in order by primary author’s last name.

The Proceedings of the AIPG/AHS/3rd IPGC 2008 Symposium is a separate document and includes full papers, extended abstracts and abstracts submitted by the presenters.

Barbara H. Murphy RG, CPG-06203
AIPG Arizona Section President 2008
General Chairperson AIPG/AHS/3rd IPGC Conference
AIPG – AHS – 3rd IPGC 2008 Symposium
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Zymax Forensics
AIPG/AHS/3rd IPGC 2008 Symposium
Meeting Schedule

Thursday, September 18, 2008

6:00 am – 6:00 pm
Field Trip – Hiking on Grand View Trail – Departs from and returns to the Radisson Woodlands Hotel and then the High Country Conference Center

Saturday, September 20, 2008

7:00 am – 5:00 pm
Registration – Radisson Woodlands Hotel Lobby
7:00 am – 8:00 am
AIPG Executive Committee Breakfast – Radisson Woodlands Hotel - Canyon Room
8:00 am – 12:00 noon
AIPG Executive Committee Meeting – Radisson Woodlands Hotel - Kaibab Room
8:00 am – 5:00 pm
Field Trip – San Francisco Volcanic Field – Departs from and returns to the Radisson Woodlands Hotel and then the High Country Conference Center
8:00 am – 5:00 pm
Field Trip – Lake Mary/Walnut Creek Watershed – Departs from and returns to the Radisson Woodlands Hotel and then the High Country Conference Center
9:00 am – 4:00 pm
Workshop – Writing for the Reader: Strategies for Communicating Technical Information Effectively – Radisson Woodlands Hotel – Mt. Elden Room
9:00 am – 4:00 pm
Workshop – Water Education – Project WET – Radisson Woodlands Hotel – Humphreys Room
9:00 am – 4:00 pm
Workshop – GIS I Introduction to ArcGIS for the Earth Scientist – NAU Campus – Applied Research and Development Bldg, Suite 226, (Bldg 56, see NAU map on page 35)
10:00 am – 10:15 am
Break – Radisson Woodlands Hotel – Canyon Room
12:00 noon – 1:00 pm
Lunch Buffet – Radisson Woodlands Hotel – Canyon Room
12:00 noon – 1:00 pm
AIPG Foundation Luncheon – Radisson Woodlands Hotel – Kachina Room
1:00 pm – 4:00 pm
AIPG Advisory Board Meeting – Radisson Woodlands Hotel – Kaibab Room
3:00 pm – 3:15 pm
Break – Radisson Woodlands Hotel – Canyon Room
4:00 pm – 5:30 pm
AIPG Joint Executive Committee Meeting and Business Meeting – Radisson Woodlands Hotel – Kaibab Room
Sunday, September 21, 2008

*Shuttle service between The Radisson Woodlands Hotel and The High Country Conference Center is available from 5:00 pm - 9:00 pm.

7:00 am – 4:30 pm
Registraion – Radisson Woodlands Hotel Lobby

7:00 am – 5:00 pm
Field Trip – Fossil Creek – Departs from and returns to the Radisson Woodlands Hotel and then the High Country Conference Center

8:00 am – 5:00 pm
Field Trip – Grand Canyon/South Rim – Departs from and returns to the Radisson Woodlands Hotel and then the High Country Conference Center

8:00 am – 5:00 pm
Field Trip – Sunset Crater/Wupatki – Departs from and returns to the Radisson Woodlands Hotel and then the High Country Conference Center

10:00 am – 10:15 am
Break – Radisson Woodlands Hotel – Canyon Room or High Country Conference Center – Humphreys Room

12:00 noon – 1:00 pm
Lunch Buffet – Radisson Woodlands Hotel – Canyon Room

12:00 noon – 1:00 pm
AIPG Past Presidents Luncheon Buffet – Radisson Woodlands Hotel – Humphreys Room

12:00 noon – 4:30 pm
Workshop – GIS II Introduction to ARC Hydro – NAU Campus – Applied Research and Development Bldg, Suite 226, (Bldg 56, see NAU map on page 35)

12:00 noon – 4:30 pm
Workshop – Students, Your First Steps in the Profession and the Future – Radisson Woodlands Hotel – Kachina Room

2:00 pm – 5:00 pm
AESE Board Meeting – Radisson Woodlands Hotel – Mt. Elden

3:00 pm – 3:15 pm
Break – Radisson Woodlands Hotel – Canyon Room

4:00 pm – 6:00 pm
AHS Foundation Board Meeting – Radisson Woodlands Hotel – Humphreys Room

5:00 pm – 8:00 pm
Registration AIPG/AHS/3rd IPGC – High Country Conference Center Lobby

6:00 pm – 8:00 pm
Welcome Reception – High Country Conference Center

6:00 pm – 8:00 pm
Exhibit Area Open – High Country Conference Center

Monday, September 22, 2008

*Shuttle service will be available between The Radisson Woodlands Hotel and The High Country Conference Center. Times will be posted at the conference.

7:00 am – 5:00 pm
Registration – AESE – Radisson Woodlands Hotel Lobby
Monday, September 22, 2008

7:00 am - 5:00 pm
  Registration – AIPG/AHS/3rd IPGC – High Country Conference Center Lobby
7:00 am – 8:00 am
  AESE – Surveys Breakfast Meeting – Radisson Woodlands Hotel – Mt. Elden Room
8:00 am – 5:00 pm
  Exhibits Open – High Country Conference Center
8:00 am – 5:00 pm
  Field Trip – Grand Canyon Sightseeing – Departs from and returns to the Radisson Woodlands Hotel and then the High Country Conference Center
8:00 am – 5:00 pm
  Field Trip – Jerome Mining District/Sedona – Departs from and returns to the Radisson Woodlands Hotel and then the High Country Conference Center
8:30 am – 5:30 pm
  AESE Sessions – Radisson Woodlands Hotel – Coconino Room (See AESE Technical Program Schedule and Abstracts on page 23)
8:30 am – 10:00 am
  Plenary Session AIPG/AHS/3rd IPGC – Prochnow Auditorium – Located South of the High Country Conference Center (See AIPG/AHS/3rd IPGC Technical Session Schedule on page 14)
10:00 am – 10:15 am
  Break – Radisson Woodlands Hotel – Canyon Room
10:00 am – 10:15 am
  Break – High Country Conference Center – Humphreys Room
10:00 am – 5:00 pm
  AIPG/AHS/3rd IPGC Technical Sessions – High Country Conference Center (See AIPG/AHS/3rd IPGC Technical Session Schedule on page 14)
11:30 am – 1:00 pm
  AESE Business Meeting Luncheon – Radisson Woodlands Hotel – Kaibab Room
12:00 noon – 1:00 pm
  Lunch Buffet – Radisson Woodlands Hotel – Canyon Room
12:00 noon – 1:00 pm
  Lunch Buffet – Includes AHS Awards and CAP Awards – High Country Conference Center – Humphreys Room
3:00 pm – 3:15 pm
  Break – Radisson Woodlands Hotel – Canyon Room
3:00 pm – 3:15 pm
  Break – High Country Conference Center – Humphreys Room
5:00 pm – 6:00 pm
  AHS Annual Meeting (All Members Welcome) – Radisson Woodlands Hotel – Humphreys Room
6:00 pm – 9:00 pm
  Dinner and Cultural Entertainment Event – Radisson Woodlands Hotel – Grand Ballroom
Tuesday, September 23, 2008

*Shuttle service will be available between The Radisson Woodlands Hotel and The High Country Conference Center. Times will be posted at the conference.

7:00 am – 5:00 pm
Registration - AESE – Radisson Woodlands Hotel Lobby

7:00 am - 4:00 pm
Registration - AIPG/AHS/3rd IPGC – High Country Conference Center Lobby

7:00 am – 8:00 am
AESE Freelancer’s Breakfast – Radisson Woodlands Hotel – Mt. Elden Room

8:00 am – 3:00 pm
Exhibits Open – High Country Conference Center

8:00 am – 5:00 pm
AIPG/AHS/3rd IPGC Technical Sessions – High Country Conference Center (See AIPG/AHS/3rd IPGC Technical Session Schedule on page 18)

8:00 am – 5:00 pm
Field Trip – Sedona and Sedona w/JEEP Tour - Departs from and returns to the Radisson Woodlands Hotel and then the High Country Conference Center

8:00 am – 5:00 pm
Field Trip – Meteor Crater – Departs from and returns to the Radisson Woodlands Hotel and then the High Country Conference Center

8:30 am – 5:30 pm
AESE Sessions – Radisson Woodlands Hotel – San Francisco Room (See AESE Technical Program Schedule and Abstracts on page 27)

10:00 am – 10:15 am
Break – Radisson Woodlands Hotel – Canyon Room

10:00 am – 10:15 am
Break – High Country Conference Center – Humphreys Room

12:00 noon – 1:30 pm
Lunch Buffet – Radisson Woodlands Hotel – Canyon Room

12:00 noon – 1:30 pm
Lunch Buffet – Speaker Bruce Aiken: Roaring Springs/Grand Canyon Presentation – High Country Conference Center – Humphreys Room

3:00 pm – 3:15 pm
Break – Radisson Woodlands Hotel – Canyon Room

3:00 pm – 3:15 pm
Break – High Country Conference Center – Humphreys Room

6:30 pm – 8:30 pm
AESE Awards Banquet – Radisson Woodlands Hotel – Grand Ballroom

6:30 pm – 8:30 pm
Reception at the Museum of Northern Arizona – Includes AIPG Awards and Recognition (Shuttle is available from the Radisson Hotel and the High Country Conference Center)

Wednesday, September 24, 2008

7:00 am – 8:30 am
AESE Board Meeting – Radisson Woodlands Hotel – Humphreys Room
Wednesday, September 24, 2008

8:00 am – 9:00 am
Registration – Radisson Woodlands Hotel Lobby

8:00 am – 3:30 pm
Workshop – Important Areas of Law-What Does the Future Hold? – Radisson Woodlands Hotel – Kachina Room

8:00 am – 5:00 pm
Field Trip – Grand Canyon/South Rim – Departs from and returns to the Radisson Woodlands Hotel and then the High Country Conference Center

8:00 am – 5:00 pm
Field Trip – Flagstaff’s Water Supplies: Past, Present, and Future – Departs from and returns to the Radisson Woodlands Hotel and then the High Country Conference Center

8:00 am – 5:00 pm
Field Trip – Montezuma Castle National Monument and Well – Departs from and returns to the Radisson Woodlands Hotel and then the High Country Conference Center

10:00 am – 10:15 am
Break – Radisson Woodlands Hotel – Canyon Room

12:00 noon – 1:00 pm
Lunch Buffet – Radisson Woodlands Hotel – Canyon Room

3:00 pm – 3:15 pm
Break – Radisson Woodlands Hotel – Canyon Room
AIPG/AHS/3rd IPGC 2008 Symposium
Technical Session Schedule
*All activities will be held at The High Country Conference Center

Monday, September 22, 2008

8:30 am – Plenary Session AIPG/AHS/3rd IPGC – Prochnow Auditorium – Located South of The High Country Conference Center
   Welcome and Acknowledgments
   Keynote Speaker: Soroosh Sorooshian, Professor, University of California – Irvine, Irvine, CA: How Predictable is the Climate System: Droughts, Floods and Extreme Events
   10:00 am – Break – Humphreys Room/Exhibit Area

10:15 am – Technical Session 1 – Energy, Water and Ethics – Doyle Room
   Moderator: Christopher Scott, University of Arizona
   10:20 – Water Scarcity and Energy: The Nexus Strengthens
   Trevor Hill, Graham Symmonds, Global Water Resources, Phoenix, AZ
   10:40 – Challenges Integrating the Need for Electrical Power Generation and Mutually Beneficial Potable Aquifer Usage/Restoration in the American Southwest
   The Water-Electricity Nexus
   David Asti, Southern California Edison, Rosemead, CA
   11:00 – So You Say Renewables Are the Answer... Let’s Talk
   James Burnell, Colorado Geological Survey, Denver, CO
   11:20 – Water, Electric Power and Growth in Southern Arizona
   Joseph Hoover, University of Arizona, Tucson, AZ
   11:40 – Northern Annular Mode Impact on Spring Climate in the Western United States
   Stephanie McAfee, CAP Award Winner, University of Arizona, Tucson, AZ
   12:00 – 1:00 Lunch – Includes AHS Awards and CAP Awards – Humphreys Room

10:15 am – Technical Session 2 – Models, Data and Ethics – Rees Room
   Moderator: Fred Tillman, USGS
   10:20 – The Importance of Geologic Information in Trenchless Technology Information Required, Responsibilities of the Geologist, and Ethical Issues
   George Davis, Missouri Department of Transportation, Columbia, MO
   10:40 – Conclusions on the Use of Model Predictions Derived From Model Post-Audits and Re-Evaluations
   Joanna Moreno, Adventus Americas, Inc., Conifer, CO
   11:00 – Watershed Restoration in Southwest Florida: A Redemptive Model
   John Murray, Associate Professor, Southern Utah University, Cedar City, UT
   Aregai Tecle, Professor, Northern Arizona University, Flagstaff, AZ
   11:40 – Creating an Environmental GIS Database
   John Kennedy, Caelum/Unitec, Las Cruces, NM
   12:00 – 1:00 Lunch – Includes AHS Awards and CAP Awards – Humphreys Room

Moderators: Robert Font, M.B. Kumar, Art Bishop, Bruce Broster, Manuel Regueiro, and Ruth Allington

10:20 – Introduction to the 3rd IPGC - Opening Remarks
Robert Font, AIPG, Geoscience Data Management, Plano, TX

10:40 – AIPG's System of Online Instruction - A Portal to Global Geoscience
Robert Font, AIPG, Geoscience Data Management, Plano, TX

11:00 – Interactive Modules of E-Learning - An Example with Google Earth
Detlev Doherr, EFG, Germany, Dean and Professor, Univ. of Offenburg, Offenburg, Germany

11:20 – The Significance of Continuing Professional Development and Credentials upon Career Opportunities
William Siok, AIPG, Westminster, CO

11:40 – Attitudinal and Economic Realities in a Global Geoscience Workforce
Christopher Keane, AGi, Alexandria, VA

12:00 – 1:00 Lunch – Includes AHS Awards and CAP Awards – Humphreys Room

1:20 – International Recognition and Cooperation, Professional Qualifications as Passports
Gareth Jones, John Clifford, Christer Akerman, EFG, Ireland and Sweden

1:40 – A Review of the CPD Programs Used by Different Professional Groups
David Abbott, AIPG, Denver, CO

2:00 – Five Points of Professionalism - Professionalism, Certification and Continuing Development in Energy Resource Geoscience: the AAPG Experience
Thomas Ewing, DPA-AAPG, San Antonio, TX

2:20 – The Practicability and Impracticability of Certification
Robert Tepel, AEG-CSMGB, San Jose, CA

2:40 – The Profession in Canada - A Review and Update
Oliver Bonham, CCPG, Canada

3:00 – Break – Humphreys Room / Exhibit Area

3:20 – Professional Registration/Licensure in the United States - A Summary
Rick Ericksen, DPA-AAPG, Jackson, MS

3:40 – A World Federation of Professional Geologists: Why the World Needs One
Manuel Regueiro, EFG, Madrid, Spain

4:00 – The Importance of Professional Titles - An Update
Dirk De Coster, Cristina Sapalski, Isabel Gomez Garcia, ICOG, Madrid, Spain

4:20 – Strategies to Successfully Recruit and Retain Women Geoscientists
Laurie Scheuing, Mary Anne Holmes, AWG, Glens Falls, NY

4:40 – An Internet Survey of Scholarships Offered by US Geoscience Professional Organizations and Foundations: Totals, Ranges, Means, Medians, Modes, Models, Motivations, and Disappointment
Robert Tepel, AEG-California State Mining and Geology Board, San Jose, CA

1:15 pm – Technical Session 4 – Human vs. Ecosystem Needs – Agassiz Room

Moderator: Boris Poff, National Park Service

1:20 – Potential Effects of Recent Climate Change on Municipal and Agricultural Water Supplies in Chile
Daniel Neary, USDA Forest Service, Flagstaff, AZ
1:40 – **Conserve to Enhance: Voluntary Municipal Conservation to Support Environmental Enhancement**  
Joanna Bate, University of Arizona Water Resources Research Center, Tucson, AZ

2:00 – **“Reference” Wetlands Refers to … What?**  
Charles Drake, Tetra Tech, Orlando, FL

2:20 – **An Analysis of Existing Literature on the Threats to Riparian Ecosystems in the Western U.S.**  
Boris Poff, USDA Forest Service, Flagstaff, AZ

2:40 – **Using Controlled Floods to Restore the Grand Canyon**  
Michael Hoenig, Northern Arizona University, Flagstaff, AZ

3:00 – **Break – Humphreys Room / Exhibit Area**

---

1:15 pm – Technical Session 5 – Water Quality – Rees Room  
Moderator: Jim Leehouts, USGS

1:20 – **Mine and Quarry Design Approaches to Limiting Environmental Effects on the Water Environment**  
Ruth Allington, GWP Consultants, LLP, United Kingdom

1:40 – **The Effects of Sand and Gravel Mining on Local Groundwater Conditions, Washtenaw County, SE Michigan**  
Frank Tokar, Jr., Natural Resources Management, LLC, Sylvania, OH

2:00 – **The Use of Storm-Water Monitoring for Evaluation of Surface-Water Quality of Lower North Potato Creek, Copper Basin Mining District, Tennessee**  
Thomas McComb, Barge Waggoner Sumner & Cannon, Inc., Nashville, TN

2:20 – **Environmental Impacts of Mining - Derived Coastal Sand Dunes, Chanaral Bay, Chile**  
Daniel Neary, USDA Forest Service, Flagstaff, AZ

3:00 – **Break – Humphreys Room / Exhibit Area**

---

1:15 pm – Technical Session 6 – Groundwater Issues and Ethics – Doyle Room  
Moderator: Nick Melchers, USGS retired

1:20 – **Certified Ground Water Professionals and the Data Quality Act**  
Robert Masters, National Ground Water Association, Westerville, OH

1:40 – **Well Siting Optimization System**  
Melanie Maguire, Golder Associates, Inc., Tucson, AZ

2:00 – **Groundwater Exploitation from a Fractured Bedrock Aquifer with Limited Storage**  
Vit Kuhnel, LFR, Inc., Scottsdale, AZ

2:20 – **Monitoring Grand Canyon Springs as an Assessment of Water Resources Response to Climate Change and Groundwater Withdraw**  
Steven Rice, National Park Service-Grand Canyon, Grand Canyon, AZ

2:40 – **Water Well Rehabilitation in Botswana, Africa**  
Robert Turnbull, Roscoe Moss Company, Los Angeles, CA

3:00 – **Break – Humphreys Room / Exhibit Area**

3:20 – **How to Improve Well Efficiency and Well Yield and Save Money**  
Charles Drake, Tetra Tech, Orlando, FL

Kade BP Hutchinson, Arizona Department of Water Resources, Phoenix, AZ

4:00 – **Lower Floridian Aquifer Alternative Water Supply Exploratory Program**  
Charles Drake, Tetra Tech, Orlando, FL
3:15 pm – Technical Session 7 – Subsidence – Agassiz Room
Moderator: Ralph Weeks, AMEC, Retired
3:20 – Land Subsidence in Arizona – Introduction and Overview
Ralph Weeks, AMEC Earth & Environmental, Inc. (retired), Tucson, AZ
3:40 – Numerical Simulation of Land Subsidence and Earth Fissure Initiation due to Ground Water Withdrawal
Muniram Budhu, University of Arizona, Tucson, AZ
4:00 – Predicting Subsidence - I've Got a Sinking Feeling
Kenneth Fergason, AMEC Earth & Environmental, Inc., Tempe, AZ
4:20 – Resistivity as a Reconnaissance Tool for Land Subsidence Potential
Michael Rucker, AMEC Earth & Environmental, Inc., Tempe, AZ
4:40 – A Synthesis of Land Subsidence and Earth Fissures in the Apache Junction - Hawk Rock Area
Muniram Budhu, University of Arizona, Tucson, AZ

3:15 pm – Technical Session 8 – Forest Watershed Management – Fremont Room
Moderator: Dan Neary, USFS
3:20 – Potential Effects of Prescribed Fire on Watershed Processes in Southwestern Oak-Savannahs
Karen Koestner, USDA Forest Service, Flagstaff, AZ
3:40 – Monitoring and Assessment of Air Pollution Effects on Forests in the Sierra Ancha Experimental Forest, AZ
Boris Poff, USDA Forest Service, Flagstaff, AZ
4:00 – Desertification and Watershed Degradation: The Role of Wildfire
Daniel Neary, USDA Forest Service, Flagstaff, AZ
4:20 – An Overview of the Cascabel Watershed Stude: Peloncillo Mountain, NM
Karen Koestner, USDA Forest Service, Flagstaff, AZ

3:15 pm – Technical Session 9 – Water Ownership: Public vs. Private – Rees Room
Moderator: Marvin Glotfelty, Clear Creek Associates
3:20 – Water Management Solutions for Rural Areas; A case study of the Upper San Pedro Partnership
Julie Jonsson, CAP Award Winner, University of Arizona, Tucson, AZ
3:40 – Private Ownership of Municipal Water Supplies in U.S. Western Mining Towns
Bob Kent, Boise State University, Boise, ID
4:00 – Comparison of Groundwater Use Under Contrasting Property Regimes in Texas and New Mexico: Is Prior Appropriation More Protective of Groundwater Supplies than the Rule of Capture?
Christopher Brooks, University of Arizona, Tucson, AZ
4:20 – Stakeholder Processes and Mutually Supportive Projects in Southwestern New Mexico Related to the Arizona Water Settlements Act
Alison Williams, Interstate Stream Commission, Santa Fe, NM
Tuesday, September 23, 2008

8:00 am – Technical Session 10 – Water Supply vs. Public Policy – Agassiz Room
Moderator: Leslie Graser, Arizona Department of Water Resources
8:00 – Pieces of a Puzzle: Why Transdisciplinary Socio-Technical Tools are Necessary
to Address Water Resource Policy
Suzanne Pierce, Sandia National Laboratories, Albuquerque, NM
State: Examples of Tribal Environmental Successes through Participation in Watershed
and Water Resource Planning Processes
David Fuller, Port Gamble S’Klallam Tribe, National Resources Department,
Kingston, WA
8:40 – Southern Drought and Thirsty Atlanta Rekindle Georgia/Tennessee Border Dispute
Lawrence Weber, TTL, Inc., Nashville, TN
9:00 – Water, Cultures, Power and Politics - Walking the Ethical Tightrope
Craig Roepke, New Mexico Interstate Stream Commission, Santa Fe, NM
9:20 – Managing Shorelines for Multiuse Reservoirs - Values, Goals, Objectives, and
Compromises
Mark Murphy, New Mexico Interstate Stream Commission, Albuquerque, NM
9:40 – Desalination of Brackish Groundwater in Arizona
Ed McGavock, Errol L. Montgomery & Associates, Prescott, AZ
10:00 – Break – Humphreys Room / Exhibit Area

8:00 am – Technical Session 11 – Water Quality: Science, Policy and Ethics – Rees Room
Moderator: Bob Hart, USGS
8:00 – Using Environmental Isotopes to Distinguish Mountain Front Recharge and Mountain
Block Recharge
Ailiang Gu, Burgess & Niple, Inc., Tempe, AZ
8:20 – Invisible Data: Dealing with Nondetect Values in Contaminant Modeling
Kevin Krogstad, URS Corporation, Phoenix, AZ
8:40 – Chattanooga Creek Site NAPL & Creosote Remediation Utilizing AquaBlok® Low
Permeability Thin Capping Approach
John Valkenburg, Adventus Americas, Inc., DeWitt, MI
9:00 – Hydrogeology and Human Health: An Intersection for Nutrition Research in
Bangladesh
Robert Merrill, Catheart Energy, Inc., Sugar Land, TX
9:20 – Is Artificial Recharge of Treated Effluent a Safe, Long-Term Strategy?
Frank Butterworth, Institute for River Research International, Prescott, AZ
9:40 – Perched Groundwater in Central Flagstaff: Implication for Identification of Sources and
Extent of Contamination
David Laney, SCS Engineers, Phoenix, AZ
10:00 – Break – Humphreys Room / Exhibit Area

8:00 am – Technical Session 12 –GIS and Water Resources – Doyle Room
Moderator: Paul Gremellion, NAU
8:00 – GIS and Water Resources - Are we Effectively Using the Tools Available?
John Kennedy, Caelum/Unitec, Las Cruces, NM
8:20 – GIS Databases and Mapping - Tools for Watershed Management, Lake Tuscaloosa, City Reservoir
Lois George, LaMoreaux & Associates, Inc., Tuscaloosa, AL

8:40 – Arizona NEMO Wet/Dry Mapping of the Agua Fria River
Kristine Uhlman, University of Arizona, Water Resources Research Center, Tucson, AZ

9:00 – Application of GIS in the Hydrology of Mine Pit Lake
Bibhuti Panda, AMEC Earth & Environmental, Tempe, AZ

9:20 – Groundwater and Solute Transport Numerical Modeling Using GIS of the Eastern Coast of Cap-Bon (Tunisia)
Adel Zghibi, Département de Génie Rural, Eaux et Forêts, Institut National Agronomique de Tunisie, Tunis, Tunisia

9:40 – Erosional or Constructional shorelines? A GIS investigation of a playa system using IFSAR
John Kennedy, Caelum/Unitec, Las Cruces, NM

10:00 – Break – Humphreys Room / Exhibit Area

8:00 am – Technical Session 13 – 3rd IPGC – Professional Ethics and the Global Geoscientist: New Horizons in Geology - Ponderosa Boardroom

Moderators: Robert Font, MB Kumar, Sue Lynn Bishop, Oliver Bonham, Dirk De Coster

8:00 – Ten Characteristics of Self Regulation Professions
Derek Doyle, APEGBC, Burnaby, British Columbia, Canada

8:20 – The Association of State Boards of Geology (ASBOG) and Geoscience Licensure in the United States
Wilson Herrod, ASBOG, Cody, WY

8:40 – Consulting Geology and the Role of Licensing
Joan Underwood, ASBOG, Sheboygan, WI

9:00 – The ASBOG Fundamentals of Geology and Practice of Geology Examinations: The Development and Administration of a National Examination
Richard Spruill, ASBOG, Grimesland, NC

9:20 – The Association of State Boards of Geology (ASBOG) and Professional Ethics
John Williams, ASBOG, Professor, San Jose State University, San Jose, CA

9:40 – Professional Geologist in the Protection of the Public – Licensure – Ethics – Society
Christopher Mathewson, ASBOG, Professor, Texas A&M University, College Station, TX

10:00 – Break – Humphreys Room / Exhibit Area

10:20 – Review of International Professional Disciplinary Proceedings: Procedures and Actions Taken
David Abbott, Oliver Bonham, Don Larking, John Gustavson, AIPG, CCPG

10:40 – The Geologist and Cognitive Diversity as a Key to Problem Solving
Shane McDonald, AIPG, Malcolm Pirnie, Inc., King of Prussia, PA

11:00 – Geology-Based Unitization of Reservoirs in the Petroleum Fields of Louisiana: An Overview
M. B. Kumar, AIPG, Baton Rouge, LA

11:20 – Unconventional Gas Resources - Are We Prepared for the Journey or Have We Already Arrived?
Douglas Kenaley, ExxonMobil, Houston, TX

11:40 – Geothermal Energy in Europe
Gareth Jones, Herald Ligttenberg, EFG, Ireland and The Netherlands
12:00 – 1:30 Lunch – Bruce Aiken: Roaring Springs/Grand Canyon Presentation – Humphreys Room

10:15 am – Technical Session 14 – Southwest Water Policy Issues – Rees and Doyle Rooms
Moderator: Brad Hill, City of Flagstaff
10:20 – Providing a Nexus Between Land Use and Water Resources – Developing Municipal Water Policies to Ensure Long-Term Sustainability
Bradley Hill, City of Flagstaff, Flagstaff, AZ
10:40 – Testing the Climate for Non-potable Water Reuse: Opportunities and Challenges in Arizona
Christopher Scott, Assistant Professor, Udall Center for Studies in Public Policy, University of Arizona, Tucson, AZ
11:00 – Two Examples of Quantification of Subflow Zone Depletion in Arizona
Jon Ford, Leonard Rice Engineers, Inc., Denver, CO
11:20 – Mapping Ground Water Vulnerability to Nitrate in Arizona
Kristine Uhlman, University of Arizona, Water Resources Research Center, Tucson, AZ
11:40 – Testing the Climate for Non-potable Water Reuse: Opportunities and Challenges in Arizona
Christopher Scott, Assistant Professor, Udall Center for Studies in Public Policy, University of Arizona, Tucson, AZ
12:00 – 1:30 Lunch – Bruce Aiken: Roaring Springs/Grand Canyon Presentation – Humphreys Room

10:00 am – Noon – Technical Session 15 – Poster Sessions – Humphreys Room
Moderator: David Best, NAU
–Chemical and Isotopic Tracers of Groundwater Recharge and Flowpaths in the Middle San Pedro Basin
Candice Adkins, USGS, Tucson, AZ
–Resampling a Ground-Water Quality Monitoring Network in the West Salt River Valley, Arizona
David Anning, USGS, Flagstaff, AZ
–Summer Base Evaluation of the Middle Verde River, Yavapai County, AZ
Donald Bills, USGS, Flagstaff, AZ
–Delineation of Recharge Areas, Groundwater Flow Pathways, and Travel Times on the Kaibab Plateau, Arizona
Chris Brown, Masters of Science in Geology Candidate, Northern Arizona University, Flagstaff, AZ
–Stochastic Model to Estimate Travel Times from the 52nd Street Facility
Daniel Burnell, GeoTrans, Inc., Sterling, VA
–Addressing the Water Quality Issues of Lake Powell
–Digital Hydrogeologic Models of Basin-Fill Aquifer Systems in the Southwestern New Mexico Border Region-A Powerful Tool for Binational Water-Resources Management
John Hawley, New Mexico Water Resources Research Institute, Las Cruces, NM
–Lake Mary Bathymetry
Nancy Hornewer, USGS, Flagstaff, AZ
–The Role of Absolute Gravimetry in Arizona’s Rural Watershed Initiative Projects
Jeffrey Kennedy, USGS, Tucson, AZ
–Characterization of the Highway 95 Fault in Lower Forty-Mile Wash using Transient Electromagnetics (TEM), Controlled Source Audio-Frequency Magnetotellurics (CSAMT), and Direct-Current Resistivity, Nye County, Nevada
Jamie Macy, USGS Arizona Water Science Center, Flagstaff, AZ

–Successful Remediation of Benzene and Trichloroethylene in Groundwater Through Stimulation of In-situ Bacterial Degradation
Ira Merin, Richard Todd Church, URS Corporation, Herndon, VA

–Spatial Patterns of Effluent Discharge and Development of Effluent Dependent Waterways in AZ
Margaret White, PhD Candidate, School of Life Science, Arizona State University, Tempe, AZ

1:30 pm – Technical Session 16 –Aquifer Recharge and Restoration – Agassiz and Fremont Rooms
Moderator: Doug Bartlett, Clear Creek Associates

1:30 – Sensor Monitoring of Aquifer Storage & Artificial Recharge
David Wardwell, In-Situ, Inc., Grand Rapids, MI

1:50 – Artificial Recharge System in Fractured Bedrock Aquifer
Bibhuti Panda, AMEC Earth & Environmental, Tempe, AZ

2:10 – In-Situ Leaching of Sandstone Uranium Deposits in New Mexico: Past, Present, and Future Concerns and Potential
Virginia McLemore, New Mexico Bureau of Geology, Socorro, NM

2:30 – Deep Aquifer Recharge Study Through Water Level Monitoring in Kathmandu Valley, Nepal
Swostik Kumar Adhikari, Kathmandu, Nepal

2:50 – Break – Humphreys Room / Exhibit Area

3:10 – Role of Remediation Hydraulics in Groundwater Restoration Accounting for Realistic Aquifer Behavior
Kevin Wilson, ARCADIS, Novi, MI

3:30 – An Integrated Simultaneous Approach to Groundwater Remediation Using Environmental Hazard Evaluation and Treatment Zone Maps
James Jacobs, Environmental BioSystems, Inc., Mill Valley, CA

3:50 – Spring Water Resources - A Case Study From Kathmandu Valley, Nepal
Pramod Simkhada, Kathmandu, Nepal

1:30 pm – Technical Session 17 –Surface Water – Groundwater A Shared Resource –
Doyle and Rees Rooms
Moderator: Abe Springer, NAU

1:30 – Evaluating Surface Water and Ground Water Interactions in a Stressed Aquifer System using an Echohydrological Approach
Ray Talkington, Geosphere Environmental Management, Inc., Exeter, NH

1:50 – Assessing a Destructive Element of Surface Water/Ground Water Interactions - Ground Water Flooding
Brent Huntsman, Terran Corporation, Beavercreek, OH

2:10 – Subsurface Groundwater Flow and Sinkhole Development Sedona, Arizona
Paul Lindberg, Consulting Geologist, Sedona, AZ

2:30 – Legal Implications of Rainwater Harvesting for Existing Surface Water Right Holders: Does Arizona Have a Problem?
Aaron Lien, CAP Award Winner, University of Arizona, Tucson, AZ

2:50 – Break – Humphreys Room / Exhibit Area
3:10 – **Cessation of Flow in the Peace River - the Hawthorn Aquifer System Connection, Polk County, Florida**
Michael Gates, Southwest Florida Water Management District, Tampa, FL

3:30 – **Ground-Water Flow for the Colorado Plateau and Adjacent Basins Simulated Using the Northern Arizona Regional Ground-Water Flow Model**
Don Pool, USGS Arizona Water Science Center, Tucson, AZ

3:50 – **Ground-Water Flow Simulated for Coconino and Yavapai Growth Projections Using the Northern Arizona Regional Ground-Water Flow Model**
Kyle Blasch, USGS Arizona Water Science Center, Tucson, AZ

1:30 pm – Technical Session 18 – 3rd IPGC – Expanding International Influence and Reach; Overcoming Challenges and Mapping successful Strategies – Ponderosa Boardroom
**Moderator:** Robert Font, Gareth Jones, Oliver Bonham, MB Kumar, Sue Lynn Bishop

1:30 – **The GEOTRAINET Programme**
Isabel Fernandez Fuentes, Herald Ligtenberg, Gareth Jones, EFG, Spain, The Netherlands, Ireland

1:50 – **Information Age, Globalization and Geoscience Enterprise: Opportunities, Challenges and the IYPE Beyond 2009**
Larry Woodfork, AIPG/IYPE, WV

2:10 – **Geological Mapping in Spain: Cost Benefit Analysis**
Manuel Regueiro, ICOG, Madrid, Spain

2:30 – **Natural Hazards in Land Use Planning: The Spanish Perspective**
Luis Suarez, ICOG, Madrid, Spain

2:50 – **Break – Humphreys Room / Exhibit Area**

3:10 – **The Terrafirma Project**
Ruth Allington, David Norbury, EFG, United Kingdom

3:30 – **Women in Geology in Spain**
Isabel Gomez Garcia, ICOG, Madrid, Spain

3:50 – **Overview of International Mine Closure Guidelines**
Dawn Garcia, SRK, Tucson, AZ

4:10 – **Climate Change and the Salinization of Potable Water Supplies: A Growing Threat Facing Development in Coastal Areas**
Bruce Broster, CCPG, Univ. of New Brunswick, Fredericton, Canada

Ashley Coles, University of Arizona, Tucson, AZ

4:50 – **The 17 August 1999 Turkey Earthquake, What Happened and What Have we Learned?**
Aydin Aras, EFG, Mineralogy Lab for the General Directorate of Mineral Research and Exploration, Turkey
Monday, September 22, 2008

8:30 am – 9:30 am – Technical Session 1: Best Practices for Guidebooks – Coconino Room
Session chair: Fred Spillhaus, Executive Director, AGU, Washington DC

1. Best Practices for Creating and Preserving Geologic Field Trip Guidebooks
   Lura Joseph, University of Illinois at Urbana-Champaign

   Most would agree that geologic field-trip guidebooks contain valuable information. In addition to providing useful background information about the geology of an area, many guidebooks report cutting-edge research. In some instances, the information in guidebooks cannot be found in any other resource. At the very least, guidebooks are part of the record of the history of the various societies and meetings. This talk will discuss some of the best practices for creating field-trip guidebooks, and some of the problems related to finding and preserving these valuable resources. In addition, some possible solutions to the problems will be presented, including a collaborative project of Geoscience Information Society and AGI GeoRef.

2. The AIPG-AHS-IPGC Grand Canyon Field Trip Guidebook
   Matt Kaplinski, Senior Research Associate, Grand Canyon Monitoring & Research Center

   Matt will speak about his experience as a geologic researcher on the Colorado River.

Discussion

9:30 am – 10:30 am – Technical Session 2: Best Practices for Archiving – Coconino Room
Session chair: Karen MacFarlane, Publication Geologist, NWT Geoscience Office, Yellowknife, Northwest Territories

3. Colorado Plateau Digital Archives: Building Good Digital Collections
   Peter Runge, Manuscripts and Digital Content Curator, Cline Library, Special Collections and Archives, Northern Arizona University, Flagstaff, AZ

   We live in a digital world and digital archives are becoming increasingly prevalent for institutions wishing to share information. The Colorado Plateau Digital Archives at Northern Arizona University’s Cline Library has been evolving for the past twelve years; this presentation will address the fundamental components of the Colorado Plateau Digital Archives and some of the lessons we have learned along the way. Topics that will be discussed include selection criteria, workflow, metadata, and discovery versus access. The presentation will conclude with some general observations and an opportunity to ask questions.
4. Reconstructing the Past: Considerations in the Development of a Museum Archival Program

Jonathan Pringle, Archivist, Museum of Northern Arizona, Flagstaff

The archival material at the Museum of Northern Arizona contains a wealth of information related to the museum's institutional machinations as well as a variety of unique and original manuscript collections from individuals who functioned outside the museum but whose activities still fell within the broader geographic area known as the Colorado Plateau. While a portion of the records have received some degree of preservation and intellectual treatment, a large backlog of unprocessed materials lies scattered among different storage locations across the museum campus. As the Museum Archives moves ahead with a strategy, it will have to consider issues of copyright, cultural sensitivity, and access with regard to its holdings and their dissemination, all the while working within a very limited budget.

Discussion

10:30 am – 10:50 am
Break – Canyon Room

10:50 am – 11:20 am – Technical Session 3: International Year of Planet Earth Update – Coconino Room
Session chair: John W. Hess, Executive Director, GSA, Boulder, Colorado

5. International Year of the Planet Earth – US National Committee Activities

John W. Hess, GSA

The International Year of the Planet Earth, as proclaimed by Resolution 60/192 of the United Nations General Assembly at its 60th Session, is a three-year event (2007–2009) aimed at promoting the contribution to sustainable development of society by using geoscience knowledge and information. It is a joint initiative by the International Union of Geological Sciences (IUGS) and UNESCO. The US National Committee (USNC) for the International Year of the Planet Earth is responsible for developing national science and outreach activities that contribute to the success of the global awareness on the use of geoscience for society. The USNC plans for a series of activities throughout 2008 and 2009. They include hosting public lectures and sponsoring shows on the PBS “Earth and Sky” series. The major US event is built around the GSA/SSSA/ASA/CSSA/GCAGS Joint Meeting in Houston in October 2008. Many US-based geoscience societies and federal agencies will be conducting IYPE-branded activities in support of the year.

Discussion

11:30 am – 1:00 pm
Lunch – AESE Business Meeting – Kaibab Room

1:30 pm – 3:00 pm – Technical Session 4: Best Practices in Maps/Imaging/Photo Editing – Coconino Room
Session chair: Richard W. Jones, Geologic Map Editor/Senior Geologist, Wyoming State Geological Survey, Laramie, WY

   Judy Colbert, Manager of Visual Resources, Gemological Institute of America (GIA), Carlsbad, California

Photography and graphics are important communication media in the earth sciences arena. Images are used in editorial publications, in marketing materials, for educational purposes, and in other practical applications. Professional photography and art can be very expensive, and so there exists a need for a system to organize and archive images and to provide easy access in order to reuse this material.

Since the preferred format for images has become digital, a digital asset management (DAM) system is fundamental to maintaining any significant collection of digital images. Images that are originally analog can be converted to digital images through scanning.

The GIA Visual Resources Library, in conjunction with other departments at GIA, developed and implemented a plan for an enterprisewide DAM system to manage the increasing number of digital images being generated and acquired. The key to a successful implementation of a DAM system lies not only in the selection of the appropriate products but, more important, in the planning of the policies and procedures the users will follow in their new workflow.

7. Digital Photography of Minerals, Gemstones and Jewelry

   Robert Weldon, Manager, Photography and Visual Communications, GIA, Carlsbad

The successful photography of small objects, such as minerals or gemstones, depends on a basic understanding of photography and a familiarity with concepts such as depth of field, aperture, and shutter speed. These should become second nature to the photographer so that more attention can be placed on photographic composition and emphasizing a subject’s most important characteristics.

Much also depends on the various tools you have to work with. The camera is one such tool. There are many options and brands when it comes to selecting a digital camera. Your selection should depend on your needs — but for close-up photography, lenses with macro capabilities are essential. Second, you should work in an area where you can control the lighting conditions to best illuminate your subject matter.

Choosing the surface (or background) for your subject is important too, and various kinds of backgrounds can be selected. An understanding of digital photo manipulations is also important because it is the final step in perfecting an image before it should be viewed, printed, or made available for publication.
8. Paleogeographic Maps: Scope, Construction, and Use

Ronald C Blakey, Department of Geology, Northern Arizona University, Flagstaff

Paleogeographic maps represent the ultimate synthesis of complex and extensive geologic data. They express pictorially, with or without additional text, the hypothetical landscape of some region during the geologic past. They need little explanation, even to the nongeologist, because most individuals are familiar with the basic information shown on the maps (water vs. land, plains, vs. uplands, vs. mountains, etc.). They can be layered to show the distribution of certain geologic data with respect to the map. Examples include paleocurrent data, grain-size data and lithology, tectonic elements, and fossil data. Maps can be prepared at many scales, usually somewhat dependent on the size of the area shown; map areas range from outcrop scale (10s of kms) to global. Maps that show relatively small regions can be extremely detailed and confined to a relatively narrow time slice, based, of course, on available detailed geologic data. Maps portraying larger areas up to global scale tend to be more generalized and average paleogeography over longer time slices.

Maps are constructed by compiling and plotting geologic information on a base map. Data are turned into rough sketches on the map, which in turn are painted in the program Adobe Photoshop. Maps are rechecked and updated as necessary. Pictorial paleogeographic maps can be used to illustrate earth history in many settings and at many levels. For example, the maps appear in books that range from preschool to professional geologic papers. In addition to books, they can be used in displays in regional and national parks, museums, and roadside displays. They have heavy usage in classrooms and lectures at all levels. Perhaps their ultimate value is that pictorial paleogeographic maps communicate with the viewer regardless of their level of understanding of geology or earth history.

Discussion

3:00 pm – 3:20 pm
Break – Canyon Room

3:20 pm – 4:20 pm – Technical Session 5: The Future of Geoscience Education – Coconino Room

9. Building a Picture of U.S. Geosciences Human Resources

Christopher M. Keane, Director, Communications and Technology, American Geological Institute, Alexandria, Virginia

At the end of 2007, AGI began the geosciences workforce data snapshots “Geoscience Currents.” This publication series provides the community and the public focused views of a specific aspect of the geosciences profession—from human dynamics to economic variables. These snapshots are done in response to rapidly rising questions which AGI has become aware of or new analyses available by AGI’s effort to develop a comprehensive analytical compendium of the geoscience profession. The first edition of this compendium will be available in early 2009.

Some clear emerging trends have been noted during the current study, some of which run counter to “popular opinion,” such as federal investment in geosciences, employment demographics, and the dynamics of geosciences programs. An overview of the major trends and issues will be presented,
including the clear disconnects between the activities on the supply side (universities) and the demand side (employers) within the United States.

For example, though many geosciences departments have closed in the last 10 years, more have actually entered our field—a few brand-new geology programs but also the evolution of outside programs such as biology and geography entering our field, employing faculty, and producing students that enter the profession. Likewise, many traditional bastions of both education and employment in the geosciences are seeing increased multidisciplinary involvement and “fade” from the center of the profession.


   Rod Parnell, Professor of Environmental Sciences and Geology, Director, Center for Sustainable Environments, Northern Arizona University, Flagstaff

The new technologies available to geoscientists through Geographic Information Systems analysis; the new demands for comprehensive water, soil, and natural resources management; and the new discussions of our future as a postcarbon society have combined to create unprecedented opportunities for a revolution in geosciences education. To create a geosciences curriculum for the 21st century, we must resolve some of the tensions that have developed. As we train our students to take advantage of the technological advances brought about by Geographic Information Systems analysis and the hardware it requires, we risk slighting fundamental academic content in favor of an emphasis on tools. As we take a wider, ecosystems perspective, considering concepts such as sustainability and resilience, we risk giving short shrift to the traditional disciplines in geology that have served us well. As we look to opportunities in a postcarbon society, we must remember that generations to come will still depend on fossil fuels, even without our current level of dependence on petroleum. In striving to achieve balance among these competing concerns, we must decide how to best train our students to master the academic background as well as the professional techniques required for the new demands of a new century.

Discussion

6:00 pm – 9:00 pm
   Dinner and Cultural Entertainment Event – Radisson Woodlands Hotel – Grand Ballroom

Tuesday, September 23, 2008

8:30 am – 9:30 am – Technical Session 6: Latest Developments in Digital Publishing – San Francisco Room
   Session chair: Pamela B. Daddow, Hydrologist/Reports Specialist, USGS Yucca Mountain Project, Denver, CO
11. E-Publishing: Current Trends and Future Directions

Michael J. Margotta, Director of Sales and Marketing, MetaPress, EBSCO Industries, Birmingham, Alabama

Online delivery of information has expanded dramatically in recent years. Users of academic information are increasingly demanding more types of content. The demand has led to willingness to pay for just the right information when it is easily located; the burden is to provide tools to locate the right information easily with business models for its access. A comprehensive hosting system can accommodate all these needs. Areas of discussion include user behavior, expanded content searching and indexing protocols, standards, the trend toward content fragmentation, the significance of metadata, and usage analytics.

12. What’s New in Online Publishing

Anna Jester, Product Manager, Online Publishing and Peer Review, Allen Press, Lawrence, Kansas

Online publishing continually evolves. Once contemporary topics are addressed and innovative features are implemented within your website, it is already time to step back and objectively evaluate the newest developments. Staying current on the latest and greatest trends can be time consuming, but there are several key trends to keep an eye on as your publication and your readership’s expectations mature. Targeted advertising, plagiarism detection and innovative content models are among the topics worth evaluation.

Discussion

9:30 am –10:40 am – Technical Session 7: Printing and Publishing – San Francisco Room
Session chair: Carole Ziegler, University of San Diego, San Diego, California

13. Publish Responsibly: Practical Solutions for Environmentally Conscious Organizations

Melanie Dolechek, Director of Marketing, Allen Press

Environmental issues are heating up as the hour’s hot topic. Sustaining our environment is important to our future, and association members, readers, and subscribers want to know how organizations are doing their part. Such sustainability solutions include the Forestry Stewardship Council, renewable energy sources, low- and no-VOC-emission inks and solvents, and digital workflows that reduce paper waste. “Greening” a publication is easier than many people realize, and it can demonstrate to members, readers, and subscribers that publishers are responsible global citizens who care about the future of the earth.


Lowell Lindsay, Sunbelt Publications, Inc., El Cajon, California

Co-publishing projects (publishing partnerships) can optimize the unique strengths of two or more cooperating organizations to develop and distribute a product or service that may be beyond the resources available to an organization acting alone. Several case studies of such partnerships with a
California-based regional publishing company illustrate joint projects that have been instrumental to the accomplishment of the respective missions of the partners.

Some examples include: Anza-Borrego: A Photographic Journey (California State Parks, Anza-Borrego Foundation/Institute, Wells Fargo Bank; and a coalition of private/public sponsors); Fossil Treasures of the Anza-Borrego Desert (California State Parks, Anza-Borrego Foundation/Institute, private sponsors); The Panda Who Would Not Eat (San Diego Zoo, Quail Botanical Gardens); History of the San Diego Symphony (San Diego Symphony); The Play’s the Thing (San Diego Performing Arts League, Dr Seuss Foundation); California Desert Miracle (Sierra Club/Earth Justice); Fire, Chaparral and Survival in Southern California (Allstate Insurance, private foundation); Kelemen Journals (The Kelemen Foundation); The Sugar Bear Story (Santa Barbara Natural History Museum); Louis Rose: San Diego’s First Jewish Settler (Agency for Jewish Education, private sponsors); Mission Memoirs (Mervyns Foundation); Mission Trails Regional Park Map (City of San Diego); and My Ancestor’s Village (Barona Tribal Council/Barona Cultural Museum).

15. Book Printing, Domestic or Overseas?

Mark McCombs, The Covington Group, Kansas City, Missouri

Printing overseas can often be cheaper, and quality is usually competitive. However, in comparing domestic and overseas printers, it is essential to look at the “big picture.” Considerations for going overseas include added freight costs; taxes, customs, duties (Who handles these? You or the printer?); cash-flow considerations; time to market; and timeliness of scientific material. Other things to consider are how production/quality problems will be handled long distance and whether good legal recourse exists in a worst-case scenario. Other elements that would rarely if ever be an issue domestically may interfere with printing overseas, such as local political restrictions, employee rights, religious concerns, etc.

In shopping for a printer, take the time to think about how you buy other things such as computers, office furniture, and consulting: at the lowest price or are there considerations outside of price? Is printing a commodity? How do ease of use, efficiency of communication, timeliness, quality, etc., figure into our decisions?

10:40 am – 11:00 am
Break – Canyon Room

11:00 am – 11:50 am – Technical Session 8: Panel discussion – Freelance Editing Today – San Francisco Room

Session chair: Beth Vairin, USGS Publishing Network, Chief, Lafayette Publishing Service Center, Lafayette, Louisiana

Panelists
Beth Vairin and Connie Herndon, USGS, Lafayette Publishing Service Center
Nicole Barlow, Purple Rock Editing, Vancouver, British Colombia
Tom Overton, Gemological Institute of America

Panelists will offer perspectives on the use of freelance and contractor personnel for publishing. Each will provide a personal perspective from the following: manager who has used contractors
successfully; manager who has not used freelancers/contractors at all; contractor turned full-time editor; full-time editor turned freelancer. We will then allow for questions from and discussions with the group at large. If time allows, we may be able to include an activity or two designed for easing anxieties about working with freelancers and contractors. It should be an uplifting and fun session.

12:00 noon – 1:30 pm
Lunch – Canyon Room

1:30 pm – 2:30 pm – Technical Session 9: General Editing Issues – San Francisco Room
Session chair: Pierrette Tremblay, Managing Editor, Elements, INRS-ETE, Québec City, QC

16. Developing Best Practice Guidelines for Writing Case Studies

Gayle Nesom and Donna Talbot, Schlumberger, Sugar Land, Texas

Case studies are commonly used throughout the oil and gas industry to stimulate current and prospective customers’ interest in products and services. Well-written case studies can be powerful sales tools because they speak directly to customers and provide facts and figures that lend credibility to marketing claims. An integral part of a service company’s marketing collateral, they are widely read on Web sites and are popular, highly effective resources for sales teams. The Schlumberger Oilfield Marketing Communications editorial team is responsible for developing the company’s case studies. Despite existing guidelines and a basic template, however, finished documents did not always meet the department’s high editorial standards. Moreover, the guidelines were inadequate for training new editors and informing submitters about what goes into a great case study. For these reasons, the team undertook a group project to improve the quality and development process of case studies. Team members reviewed information-gathering tools, the typical source information obtained from subject matter experts, and numerous completed case studies. They concluded that the information provided by the experts was often insufficient to create a compelling story, that the project brief form was inefficient and overwhelming to users, and that the team needed better guidelines.

On the basis of these results and the group’s best practices, the team developed new, detailed guidelines. The updated materials are available to subject matter experts on an internal Web site. As a result of this project, the team has a better grasp of how to develop powerful case studies and is more effectively communicating with subject matter experts when developing the studies. The team expects that this streamlined process will produce more compelling case studies. All these materials are living documents, and the goal is to regularly review, update, and improve the relevant processes.

17. Avoiding Death by Detail: Maintaining Quality in a Fast-Paced Environment

Margaret Read, Schlumberger

One guarantee when you work in a busy environment is that you will never be bored. If you are a single editor with many masters, you are at the beck and call of any number of product experts, coworkers, deadlines, and the often complex production system of which you are a part. You will be challenged by a variety of subjects that can put your mind through contortions and written materials that range from hastily assembled to “almost but not quite there,” and your patience and your stress
level will be well exercised. Of course, very few will commiserate because they have priorities of their own.

So what do you do?

Create your own system. Think of it as a routine, an assembly line peopled by one—you. Establish your process so that it works for you and works within the organization for maximum efficiency. Simplify by having well-oiled tools in place and as many of your wits as you can muster about you. There are numerous ways to streamline the process. Determine the level of detail required for each project, avoid the ubiquitous focus busters, and most important, maintain perspective. Remember that you are just a cog in a large machine. Take each day as a single, complete life cycle to be negotiated anew every morning. Flexibility, patience, and diplomacy go a long way, and it’s your own attitude that will make or break your sanity.

Discussion

2:30 pm – 2:50 pm
Break – Canyon Room

2:50 pm – 3:50 pm – Open Discussion on AESE Direction – San Francisco Room
Facilitators: Rowena Mills, SEG, AESE President; Tom Overton, AESE Vice President

Some issues to be discussed:

- **AESE has moved much of its member benefits online, particularly the Blueline and member directory. Are these online benefits serving our members’ needs? How many of you visit the AESE web site regularly?**
- **AESE membership is skewed toward older members of the profession. How do we attract younger and newer entrants to the earth sciences?**
- **Large earth science organizations, such as GSA, are rethinking the ways they interact with smaller groups such as AESE. What should our role be in the larger earth science context? What can we get from our relationships with these other groups, and what can we do for them?**
- **The AESE listserv has experienced some hiccups this past year, and sees very little activity. Would an internet discussion forum better serve members’ needs? Would anyone visit it?**

6:00 pm – 8:30 pm
AESE Awards Banquet – Radisson Woodlands Hotel – Grand Ballroom
Flagstaff Area Map
REVIEW OF INTERNATIONAL PROFESSIONAL DISCIPLINARY PROCEEDINGS

David M. Abbott, Jr., AIPG CPG, FAusIMM (CP Geol), EurGeol. PG-TX, UT, & WY, Chairman, AIPG Ethics Committee and member, AusIMM Ethics Committee, Oliver Bonham, P.Geo., Chief Executive Officer/Chief de la direction, Canadian Council of Professional Geoscientists/Conseil Canadien de Géoscientifiques Professionnels; Don Larkin, FAusIMM, Chief Executive Officer (1999-2008), Australasian Institute of Mining & Metallurgy; and John B. Gustavson, AIPG CPG, 2008 President of American Institute of Minerals Appraisers

This paper examines disciplinary procedures internationally by comparing, by way of example, the procedures at the American Institute of Professional Geologists (AIPG), the Australasian Institute of Mining & Metallurgy (AusIMM), the American Institute of Mineral Appraisers (AIMA), and the typical procedures of the constituent member associations of the Canadian Council of Professional Geoscientists. The fundamental goal of the self-regulation function of professional organizations is to assure the general public that those who violate the relevant codes of professional ethics or conduct will be appropriately sanctioned.

All inquiries into allegations of violation involve several distinct steps. Each allegation must be formally received by the organization. The allegation must then be reviewed to determine if sufficient information has been provided to support the alleged violation and to allow for further inquiry. At this stage the procedure is usually turned over to an investigator or investigating panel and the proposed respondent is notified of the initiation of the inquiry. Further investigation is usually required to clarify important facts and to develop sufficient evidence on which to base the formal charges, if warranted, that will be the subject of a formal hearing before a disciplinary panel. The formal hearing allows both the organization and the respondent to present their respective sides of the matter. The disciplinary panel then determines findings of fact, reaches a verdict with respect to the charges and sets down the penalties or sanctions to apply to the violator. Decisions of a disciplinary panel are subject to appeal, either at a higher level within the organization itself (officers or members of the board) or in a court of law. Arbitration to resolve the matter may also be available. To the degree possible, inquiries and settlement discussions are conducted by correspondence.

Differences in procedures will be illustrated, which include: the differing formation and roles of the committee (or committees) that handle complaints, investigations and hearings, as well as the appointment of an investigator (or investigators); arrangements to avoid the need for a formal hearing by an admissions of guilt and acceptance by the violator of an agreed penalty; the opportunity (or not) of an accused member to terminate the proceedings by resigning his or her membership; the ability of some organizations to proactively initiate an investigation; and the range of powers different organizations have with respect to the penalties that they can apply, which in some instances extend to imposing fines and collection of legal costs.

The violations that were the cause of actions included: false or misleading statements in professional reports and/or their summaries in a public prospectus or other disclosure statement, incompetent practice (including practice outside an area of professional competence), misrepresentation of professional qualifications, unauthorized disclosure of confidential information, undisclosed conflicts of interest, failure to correct factual errors after the error was recognized, failure to comply with an applicable disclosure code or report (JORC Code, Canadian NI 43-101 and 51-101 disclosure reports, etc.), and failure to comply with an applicable law or regulation such as not having a required professional license. The cases reviewed indicate that ethical violations viewed similarly and the actions taken and sanctions imposed are reasonably consistent among the organizations reviewed with the exception of the ability to impose fines.

A Review of the CPD Programs Used by Different Professional Groups

David M. Abbott, Jr., AIPG CPG, FAusIMM (CP Geol), EurGeol, FGS (Ch Geo), PG-TX, UT, WY Consulting Geologist LLC, Denver, Colorado

Most of the geoscience professional organizations that have a code of ethics include a statement encouraging members to maintain and expand their professional knowledge and skills; that is to engage in continuing professional development (CPD) (the specific name varies among organizations). Such statements are aspirational in that no minimum amount of CPD is required. Most, but not all, professional geoscientists do engage in voluntary CPD by reading professional journals, attending professional meetings, taking short courses and for-credit courses, attending field trips, engaging in various types of company-sponsored or regulation-required training sessions, etc.
In the past decade or so the increased emphasis on chartering, licensing, or certification of professionals has been accompanied by the adoption of minimum CPD requirements by many professional organizations involved in professional chartering, certification, or licensing. In adopting minimum CPD requirements, the formerly aspirational principle has been modified to a rule.

The various CPD schemes I’m familiar with have many things in common. These include recognition that CPD can be acquired in the various ways listed previously. They also recognize that CPD includes acquiring or updating skills that are job related but are not strictly geoscience in character. Such activities include activities such as learning about regulations applicable to one’s area(s) of professional practice, regulation-required training, safety training, computing skills, professional ethics, etc. The CPD programs frequently allow the minimum requirements to be met over a period; 3 years being common, although some have annual minimum requirements. They also recognize that the most practical means of tracking one’s professional activity is on the basis of contact hours, that is, the hours actually devoted to the CPD activity.

The chief differences between CPD programs include the minimum number of CPD credit required, how various activities for CPD credit are weighted, whether they require that one’s CPD credits must be distributed among various types of CPD activity, how one tracks one’s CPD activities (the CPD log), how one’s CPD activities are verified by the sponsoring organization, and whether one can report one’s CPD activities electronically.

It would be nice if all CPD programs agreed on a single set of reporting requirements so that one would only need to complete one CPD reporting form that would be accepted by all, but this is unlikely to ever be the case. As a practical matter, tracking one’s CPD activities requires that one keep a good calendar, diary, or log of one’s professional activities. This basic record then allows one to complete the required CPD reporting forms as necessary. If one has good time records of one’s professional (and CPD) activities, I believe that most professional geoscientists find that they have no problem meeting the minimum CPD reporting requirements.

**DEEP AQUIFER RECHARGE STUDY THROUGH WATER LEVEL MONITORING IN KATHMANDU VALLEY, NEPAL**

Swostik Kumar Adhikari

Kathmandu Valley is an intermontane basin situated in the Lesser Himalayas of Central Nepal, which has Kathmandu, Lalitpur and Bhaktapur cities with total area of about 650 sq. kms. Groundwater in Kathmandu Valley has been extensively used since long time through stone spouts (dhunga dharas) and the dug wells. The water in these stone spouts and dug wells is coming from upper aquifer which is shallow in depth. Due to increase in urbanization the surface area for infiltration is decreased and therefore there is problem in getting water from these stone spouts and dug wells.

Groundwater found in Kathmandu Valley occurs under unconfined, semi confined and confined conditions. There are three groundwater districts in Kathmandu Valley, i.e. northern groundwater district, central groundwater district and southern groundwater district. The northern groundwater district includes principal water supply well fields.

For the study, 45 deep tubewells were selected in Kathmandu Valley which represents all three groundwater districts. Among these deep tubewells 37 tubewells were selected for static water level monitoring and 8 tubewells were selected for pumping water level monitoring. Groundwater monitoring was done once a month and this investigation has been initiated in the valley by the GWRDP for MWSDB.

The monitoring data and available well lithologs show that northern groundwater district is potential for groundwater exploration. Due to the presence of excessive granular material near the surface, the area is favorable for the groundwater recharge. Central and southern groundwater district have mainly confined aquifer below thick impermeable clay layer. This clay layer prevents the recharge from the precipitation. The static water level monitoring data shows that the groundwater level in Kathmandu Valley is decreasing from 2000 to 2005. During these six years the static water level of the northern groundwater district is decreased more in comparison to other two groundwater districts.

In northern groundwater district, the peziometric level is declined from few cm to 17 m. Similarly in central and southern groundwater district, the peziometric level is declined from 1 m to 13m. The maximum fluctuation difference in water level is seen around Bansbari area in northern groundwater district. This may be due to the distribution of much coarser sediments (gravels) in this area.

The annual average rainfall was 1437.25 mm, 2003.70 mm, 1743.64 mm, 1551.25 mm and 1195.65 mm from 2000 to 2005. Though the static water level is decreased from 2000 to 2005, the trend of decreasing is faster in the recent years (i.e. 2005) in comparison to past (i.e. 2000). This may be due to less rainfall in recent years and decrease in infiltration area because of increase in urbanization.
The fluctuation in the static water level in the deep tubewells shows that these tubewells are being recharged. The groundwater level in deep tubewells of all the three groundwater districts is increased during the rainy season or just after the rainy season. The monthly monitoring data shows that the natural recharge in the deep aquifer does take place.

USE OF CHEMICAL AND ISOTOPIC TRACERS FOR ESTIMATING GROUND-WATER RECHARGE, FLOW PATHS, AND RESIDENCE TIMES IN THE MIDDLE SAN PEDRO WATERSHED, ARIZONA


Ground water in the middle San Pedro watershed in southeast Arizona is the main source of water for domestic, industrial, and agricultural use. As the population and demand on water resources increases, an improved understanding of the ground-water system is needed for effective water management. This study couples elemental and isotope ($^{18}$O, $^2$H, $^3$H, $^3$S, $^{13}$C, $^{14}$C) chemistry of ground water with hydrogeologic data (e.g. hydraulic head, subsurface structure, and stratigraphy) to infer ground-water recharge areas and ground-water interactions with the San Pedro River.

The middle San Pedro watershed contains upper and lower alluvial aquifers of sand and gravel separated by confining beds of silt and clay. The aquifers are bounded by crystalline and carbonate rocks of the Whetstone and Rincon Mountains on the west, and by crystalline rocks of the Rincon and Dragoon Mountains to the north and east. These mountain blocks contain distinctive mineral assemblages. As these mineral assemblages dissolve, they may create a distinctive chemical “fingerprint” in the ground water that flows through and down-gradient of them. These can be used as chemical tracers for identifying ground-water recharge areas and flow paths from the eastern and western sides of the watershed to the San Pedro River.

Initial analyses of ground-water samples, combined with chemical data from the Arizona Department of Environmental Quality and the U.S. Geological Survey, indicate distinct chemical compositions throughout the watershed and between the upper and lower aquifers. Water types indicated by solute chemistry are CaMgHCO$_3$ and NaHCO$_3$, in which the latter is hypothesized to be generated by cation exchange with clays, and CaSO$_4$ type waters from gypsum dissolution and pyrite oxidation.

Stable-isotope data suggest that ground water in the upper and lower aquifers is a mixture of recharge originating from winter frontal and summer monsoon precipitation with $\delta^{18}$O ground-water values ranging from -7 to -12‰. Recharge to the upper aquifer originates mostly from summer monsoon precipitation especially along certain reaches of the San Pedro River, whereas recharge to the lower aquifer originates from a mixture of annual precipitation. $^{14}$C and $^3$H age dating indicate that ground-water recharge to the upper aquifer has occurred within the past fifty years and that recharge to the lower aquifer occurred within the past 14,000 years.

MINE AND QUARRY DESIGN APPROACHES TO LIMITING ENVIRONMENTAL EFFECTS ON THE WATER ENVIRONMENT

Ruth Allington, GWP Consultants LLP, Oxfordshire, UK, Clive Carpenter, GWP Consultants LLP, Oxfordshire, UK, Dr Robin Hall, GWP Consultants LLP, Oxfordshire, UK

The relationship between quarries and surface mines and their environment is both close and complex throughout the life-cycle of such an operation; from the planning and design phase, through the operational phase to the post-closure phase. Characterisation of the ‘environmental footprint’ of such operations is an exercise in assessing the overall balance of negative and positive environmental effects. An objective to ‘minimise environmental footprint’ is an objective to reduce to a minimum the overall negative effects either by mitigating those effects directly or by balancing them with other positive effects, or both.

The water environment is a key component of ‘environmental footprint’ that must always be considered for quarrying and surface mining projects. The water environment can be both a receptor of positive and negative effects of quarrying and surface mining, and a source for effects on the operation itself or the wider environment beyond the operational site limits.
The paper will present a range of techniques and methodologies relevant to reducing the negative impacts of quarrying and surface mining on the water environment and introducing short and long term benefits where possible. It will particularly draw on relevant research, review and development projects undertaken by GWP and others in the UK and funded or co-funded over the past 6 years by the Aggregates Levy Sustainability Fund (ALSF). It will present a number of case histories to demonstrate the benefits of a systematic and integrated approach to water resources management and protection through appropriate environmental assessment at regional (strategic) and site-specific levels and application of an open-pit design process that sets out to achieve a balance between commercial, operational and environmental constraints.

RESAMPLING A GROUND-WATER QUALITY MONITORING NETWORK IN THE WEST SALT RIVER VALLEY, ARIZONA

David W. Anning, USGS, Flagstaff, AZ, Alissa L. Coes, and Henry W. Sanger

The West Salt River Valley in Central Arizona is home to over 1.4 million people that live in Phoenix and other cities in the metro area. Land cover within the basin was primarily rangeland until the 1870s when settlers began to replace native vegetation with irrigated agriculture. During the late 20th century, population growth and the accompanying conversion of agricultural and desert land to urban land continued to alter the landscape and in 1995 about 19 percent of the basin was agricultural and 22 percent was urban lands. As part of the National Water-Quality Assessment (NAWQA) Program, the U.S. Geological Survey collected and analyzed ground-water samples from 35 wells in the West Salt River Valley during 1996–97. These samples were used to characterize overall ground-water quality in the basin-fill aquifer, an important drinking-water supply for the valley residents. Analytes included the principal inorganic constituents, nutrients, trace constituents, pesticides, and volatile organic compounds. Results from this study indicated that detections and concentrations of some analytes were related to land and water use.

Population growth and land cover change has continued since the initial sampling twelve years ago, and the NAWQA Program plans to resample the network of 35 wells again in 2008. The same suite of compounds will be analyzed for, and in addition, dissolved gases and tritium/helium isotopes will be collected to help constrain ground-water ages and recharge sources. Similar ground-water quality networks are being resampled in other States across the country as part of the NAWQA Program. Comparison between the two sampling periods for detections and concentrations of each compound found in the well network could be used to answer questions like:

- Have detections or concentrations increased or decreased over time at each well, and for the network of wells?
- Are there common factors associated with wells where there was a change in detection or concentration?
- Were these common factors natural and uncontrollable, or were they human related – perhaps something that potentially can be controlled through land and/or water management?
- What about wells with no change? Were there common factors associated with these wells?
- Do the factors associated with changing or unchanging water chemistry give insight to strategies for protecting the quality of the basin-fill aquifer?

THE 17 AUGUST 1999 TURKEY EARTHQUAKE, WHAT HAPPENED AND WHAT HAVE WE LEARNED?

Aydın Aras, General Directorate of Mineral Research and Exploration, Ankara 06520

The objective of this paper is to provide a brief overview of some general lessons learned from the 17 August 1999 Turkey earthquake. Many scientific reports were written with different point of view by scientist around the world. Geologists, civil engineers, local government employees, and builders in Turkey draw many lessons from these reports. This paper tries to summarize all of them. They are divided into several themes emerging from the lessons of the 1999 Turkey earthquakes.

CHALLENGES INTEGRATING THE NEED FOR ELECTRICAL POWER GENERATION AND MUTUALLY BENEFICIAL POTABLE AQUIFER USAGE/RESTORATION IN THE AMERICAN SOUTHWEST

THE WATER – ELECTRICITY NEXUS

R. David Asti, CPG-09044, Southern California Edison, Rosemead, CA

High quality water supplies and reliable power are critical resources needed to sustain and enhance life and support the economy, environment, public health and welfare. Steam cycle power plants utilizing closed cycle wet cooling systems are relatively energy efficient, but consumptively use large volumes of water. The alternative to closed cycle wet cooling systems are dry
cooling systems; unfortunately, dry cooling systems do not function with high thermal efficiency in areas of high ambient summer temperatures. Reductions in thermal efficiency result in greater fuel consumption and greater greenhouse gas generation per megawatt of power produced. Summer represents the season with the highest peak electricity loads on the grid system, exacerbating the dry cooling issues and reinforcing the need for closed cycle wet cooling system generation.

With the increasing demands on water supplies by the growing population in the Southwest, water use for power plant cooling has been limited. In California, this use has been limited by state policy. However, the large water demands of such facilities can be used beneficially to remediate degraded groundwater systems, prevent groundwater degradation, and concentrate wastes for disposal. This remediation can restore or expand the availability of groundwater resources for municipal and industrial use. However, use of degraded water supplies results in environmental and regulatory challenges. Design of such remediation schemes requires strategic design and close coordination with agencies regulating water use, water quality, and solid waste disposal. The Mountainview Power Plant in Redlands, California, is presented as a model to illustrate the design and implementation of such a system.

CONSERVE TO ENHANCE: VOLUNTARY MUNICIPAL CONSERVATION TO SUPPORT ENVIRONMENTAL RESTORATION
Joanna Bate, University of Arizona Water Resources Research Center, Tucson, AZ,
Dr. Sharon B. Megdal, Andrew Schwarz

This presentation describes the Conserve to Enhance mechanism, an innovative approach to providing water for environmental needs. While check-off donation programs used elsewhere provide a funding source for environmental water sources, this project focuses on voluntary municipal water conservation as a source of water for environmental restoration. Existing water conservation programs may not effectively target water users that are motivated by environmental concerns. Riparian restoration projects have an ongoing need for supplemental inputs of water (Megdal et al, 2006). Also, public concern surrounding the need to protect natural water flows is growing (Katz, 2006). In recent papers, the authors proposed a mechanism, called Conserve to Enhance, by which voluntary municipal water conservation could provide funds to cover the cost of acquiring and delivering water to environmental enhancement projects (Schwarz and Megdal, 2007; Megdal, 2008). The authors have explored some of the basic elements as well as challenges involved in implementing this concept.

Under the Conserve to Enhance program, participants that reduce water use pay for water they do not use, creating a fund to purchase water for environmental purposes. The Conserve to Enhance mechanism provides a tool for addressing past degradation caused by the extraction of water from the environment. At regional scales, it may be useful to provide support for larger projects, such as agreements to restore heavily degraded ecosystems like the Colorado River Delta, the Sacramento-San Joaquin Delta, or the Chattahoochee and Apalachicola Rivers. Our research has shown that Conserve to Enhance programs may be most appropriate for use in municipalities to support local environmental enhancement projects, thus providing an initial test of this concept (Schwarz and Megdal, 2007). Discussions with regional water experts have brought forth issues related to measuring conservation, cooperating with water utility partners, competition for scarce resources, and management and allocation of funds generated by the program. The current phase of the project seeks to pilot the Conserve to Enhance mechanism, by expanding outreach with local and regional stakeholders to discover possible partnerships and by identifying opportunities for and obstacles to implementing the program at a variety of scales.

SUMMER BASE FLOW EVALUATION OF THE MIDDLE VERDE RIVER, YAVAPAI COUNTY, ARIZONA
Donald J. Bills, USGS, Flagstaff, AZ

The population in the middle Verde Valley from near Clarkdale to Camp Verde, Arizona, is projected to double by 2050 with attendant increasing water demands. Base-flow discharge between the U. S Geological Survey streamflow-gaging stations near Clarkdale (09504000) and near Camp Verde (09506000) was measured along with selected diversions, return flows, and the main tributaries during the summer of 2007 by the U.S Geological Survey. About 85 sites on the Verde River and its main tributaries—Oak Creek, Wet Beaver Creek, and West Clear Creek—were selected and measured for flow, temperature, specific conductance, pH, and dissolved oxygen as field parameters representative of summer base-flow conditions. In addition, water samples were collected by the U.S. Geological Survey at selected sites for major ion and isotope analysis by the University of Arizona. These data were used to provide a better understanding of the hydrologic system and the hydrologic connection between aquifer units in the middle Verde Valley and the base flow of the Verde River.
The middle reach of the Verde River and its main tributaries comprise a complex river system with 67 documented diversions (ditches and river pumps), and many more undocumented diversions and portable river pumps. Few of the many return flows on the Verde River and its tributaries have ever been fully documented and many of them change location from year to year owing to washouts and changing stream channel conditions. During the base-flow survey, an attempt was made to document all river and tributary diversions and return flows, however, not all of these sites could be measured. Of a total of 179 sites observed, 64 percent, or 114 sites were measured.

Preliminary evaluation of the data show that ditch and river pump diversion, return flows, and summer evapotranspiration play significant roles in the summer base flow of the middle Verde River and its tributaries, resulting in distinct gaining and losing reaches. When adjusted for diversions and return flows, the data also suggests that base flow in the Verde River gains and loosens water from/to ground-water resources of the middle Verde Valley including the C and the Redwall-Muav aquifers and the Verde Formation. Base flow for this June 2007 survey was less than flows measured by either of the U.S Geological Survey data sets collected in June 1977 and June 1979, and a data set collected in the November, 2006 by the Nature Conservancy.

GROUND-WATER FLOW SIMULATED FOR COCONINO AND YAVAPAI GROWTH PROJECTIONS USING THE NORTHERN ARIZONA REGIONAL GROUND-WATER FLOW MODEL

Kyle Blasch, USGS Arizona Water Science Center, Tucson, AZ
Don Pool, USGS, Tucson, AZ

The availability, occurrence, and movement of water in the arid and semi-arid regions of northern and central Arizona is primarily dependent upon the aquifer systems that underlie the Colorado Plateau within the study area, the upper and middle Verde River watersheds, and the Salt River basin. In cooperation with the Arizona Department of Resources, Coconino County, and Yavapai Counties, the U.S. Geological Survey ran multiple future development scenarios through the ground-water model to predict future impacts to the ground-water flow system and surface water resources.

The scenarios were based on projected population increases for both rural communities and urban municipalities within Yavapai and Coconino Counties. Scenarios also considered interbasin transfers of water from adjacent basins and from surface waters outside of the model domain such as Lake Powell. Results from the scenarios provide water managers potential regional impacts of particular development scenarios, enabling them to make more informed decisions and planning for mitigation and/or monitoring strategies. Particularly important are the impacts of future development scenarios on major rivers and springs within the study area including the Verde River and tributaries to the Little Colorado River.

THE PROFESSION IN CANADA – AN OVERVIEW AND UPDATE

Oliver Bonham, M.Sc., P. Geo. – CEO, Canadian Council of Professional Geoscientists

Geoscience is now a regulated profession in all but one province and one territory in Canada through license-to-practice legislation that places each individual P. Geo. Under a code of Ethics and makes them directly accountable to the public for the geosciences work they perform.

Licensure and governance of the profession in each province and territory in Canada is administered by a separate self-regulating professional body set up under statute in that jurisdiction. The same statutes also prohibit unlicensed geoscientists from practicing.

The Canadian Council of Professional Geoscientists (CCPG) is the national umbrella organization of the provincial and territorial regulating bodies – its constituent associations.

This paper will provide an overview of how the profession is regulated in Canada, including discussion on some of the unique challenges associated with co-regulation of the profession together with the engineering profession in some, but not all, jurisdictions. It will also outline recent developments and ongoing tasks, and reflect on future challenges of CCPG in its work on behalf of its constituent associations.

One of the key challenges that CCPG and its constituent associations foresee is how best to address true protection of the public interest through direct legal accountability by the individual professional, in a discipline that is inherently global and trans-jurisdictional in nature. And on that must operate in the increasingly instantaneous, virtual, mobile and borderless global practice environment that is a reality today and which will only extend to new levels and unforeseen dimensions into the future.
GROUNDWATER USE IN TEXAS AND NEW MEXICO: PRIOR APPROPRIATION VERSUS THE RULE OF CAPTURE  
Christopher J. Brooks, University of Arizona, Tucson, AZ

This paper examines groundwater use under differing property regimes in adjacent areas of west Texas and eastern New Mexico, where climate, land area, farming practices, and population are similar. The significant difference between the states, for purposes of this paper, is the legal regime governing access to groundwater. In New Mexico access to groundwater is governed by the doctrine of prior appropriation coupled with a rigid permit system that limits the establishment of new appropriative rights to groundwater in “declared” basins, thereby protecting existing pumping rights even further. Texas, by contrast, governs access to groundwater by the rule of absolute ownership (also called the rule of capture – the terms are used interchangeably in this paper), under which property owners are unrestricted in their ability to pump groundwater beneath their property.

Using the economics of property rights it is predicted that landowners will pump more water and irrigate more acreage in Texas under the rule of absolute ownership than will similarly situated landowners in New Mexico, whose ability to pump groundwater is relatively limited under the prior appropriation doctrine. This region provides a unique natural laboratory for testing the effect of the property regime on the behavior of irrigators because of the property rights dichotomy it presents.

Data is compiled from existing sources and used to compare amounts of irrigated acreage and groundwater pumpage for irrigation in counties along the border between eastern New Mexico and the Panhandle area of Texas. This data suggests that the rule of capture results in significantly greater groundwater pumpage and irrigated agriculture in Texas than is occurring across the border in New Mexico.

CLIMATE CHANGE AND THE SALINIZATION OF POTABLE WATER SUPPLIES: A GROWING THREAT FACING DEVELOPMENT IN COASTAL AREAS  
B.E. Broster, Department of Geology, University of New Brunswick, Fredericton, New Brunswick, E3B 5A3, Canada

Understanding what climate change truly means to any region requires identifying potential impacts and planning adaptation strategies. Like other nations of the world, Canada, as well as its component provinces, has been quick to move towards meeting the challenges facing future land-use and sustainability of current levels of care for the environment and quality of life. The Canadian Government’s Impacts and Adaptation program defines adaptation as any modification to a system or process made in response to climate change. Adaptation strategies will rely heavily on contributions from scientific research, that to date have concentrated on obvious threats. In coastal areas inundation from rising sea level is widely accepted as the major environmental problem many will face. However, beside the loss of land and changes to coastal erosion patterns, few governments have considered the threat of salinization of potable water sources and the topic remains devoid of study for planning sustainable rates of extraction, changes in land-use, or the need for legislated remedies.

Recent studies in New Brunswick, on Canada’s east coast, demonstrate that rising sea level will threaten both potable groundwater and surface water supply in coastal areas. As in other regions previously glaciated, estuarine valleys occur along all of Canada’s coastlines. Most estuarine valleys represent overdeepened glacial troughs cut during glacial advance, to depths of several tens of metres below the elevation of present sea level. During glacial melting these valleys were filled by glacialic sand and gravel accompanied by eustatic rise. The valleys and low-lying coastal plains were occupied by sea water until isostatic rebound raised coastal areas to near present elevations.

The occurrence of brackish water in coastal areas will be exacerbated by saline groundwater intrusion, and by a migrating saltwater wedge that occurs along the bed of many low-gradient estuarine rivers that demonstrate the effects of tide-head. Groundwater exploration programs in New Brunswick frequently encounter brackish water underlying potable water at depths between 59m and 256m at sites within 75km of the coast. One cause is saline intrusion along coastal areas, another is due to migration of a saltwater wedge and intrusion into aquifers along estuary valleys, and a third is attributed to pockets of remnant seawater remaining from marine incursion following deglaciation of the area. Currently, groundwater from local aquifers at shallow depths is within acceptable limits of the Canadian Drinking Water Quality but this resource is being threatened by the few policies governing extraction rates and land-use.

At approximately 18,000ha in surface area, Grand Lake is the largest lake in New Brunswick and contributes to recharge of groundwater and to surface extraction of potable water. The lake drains through marshland along the Jemseg River into the Saint John River, an estuary emptying into the Bay of Fundy approximately 70 km downstream of the lake. The river gradients are low, with the lake elevation approximately 2m above sea level. The effect of tide head results in a rise in river level in this area, most obvious during the fall season and during storm conditions at high tide. Although a wedge of brackish water along the bed of the Saint John River extends almost to the lake, present chloride concentrations at various sites within the lake, are commonly found
to be less than 10 ppm. However, analyses of drill core samples from the Jemseg marshland indicate a long history of submergence under brackish water conditions since deglaciation of the area, with the lake becoming potable some time after 8,000 yBP.

These observations indicate that in coastal areas of Canada and other previously glaciated regions of the world, rising sea levels will result in a rise in the elevation of the saline/potable groundwater boundary and decreased storage capacity for potable groundwater supplies. Thorough knowledge of the geological and hydrological environment relative to water extraction rates and land use is fundamental to fully protect potable water resources and ensure future sustainability as a prelude to climate change. Geoscientists must be in the forefront of acquiring the necessary basic research to maintain potable water resources. This is not only because they have expert understanding of Earth systems, but because these systems are physically linked and probable changes can be predicted. In this regard geoscientists have an ethical responsibility to inform governments of the research required to develop successful strategies for adaptation to climate change.

**DELINEATION OF RECHARGE AREAS, GROUNDWATER FLOW PATHWAYS, AND TRAVEL TIMES ON THE KAIBAB PLATEAU, ARIZONA**

*Chris R. Brown*, Northern Arizona University, Flagstaff, AZ

Roaring Springs is the sole supply of potable water to the 4.4 million annual visitors and employees at Grand Canyon National Park. Roaring Springs and other karst-fed springs on Grand Canyon's North Rim also provide baseflow to the Colorado River and support important riparian habitats along tributary canyons. Proposed use of the land north of Grand Canyon National Park may dramatically affect the quality and quantity of water discharging from North Rim springs. Grand Canyon National Park needs a better understanding of the karst systems on the North Rim and groundwater flowpaths to Roaring Springs and others. This understanding can be achieved by better constraining an existing conceptual model (Ross, 2005), using stable isotope analyses from spring and precipitation samples to indicate the timing of recharge and the travel-time of water from recharge to discharge, and by using basic cation/anion analyses to interpret groundwater flowpaths and to determine the correct tracing agent for a deep-karst tracer study on the North Rim.

Fieldwork for this study occurred between July 2007 and July 2008. Flow data for Roaring Springs (above and below the springs), Bright Angel Creek, Emmett Springs, Angel Springs, The Trancept, and Phantom Creek were collected and analyzed with other limited historical data. Water samples from all of the flow measurement locations in addition to both Monsoon and winter precipitation samples from the North Rim were analyzed for 18O and 2H concentrations and were interpreted relative to global and local meteoritic water lines. A conceptual triple-porosity numerical flow model of the hydrogeologic system connecting the Kaibab Plateau to North Rim springs will be presented which incorporates all these new data.

**NUMERICAL SIMULATION OF LAND SUBSIDENCE AND EARTH FISSURE INITIATION DUE TO GROUNDWATER WITHDRAWAL**

*Muniram Budhu*, University of Arizona, Tucson, AZ, *Amit Shelke*

Land subsidence has caused extensive damage worldwide. In Arizona, USA, for example, differential land subsidence caused millions of dollars of damages to buildings, utilities and transportation systems, and loss of property values. The consequences of differential land subsidence are structural distress of infrastructural systems and ground fracturing such as earth fissures and polygonal cracks. Earth fissures are approximately vertical to arcuate cracks in the ground suspected to extend deep into the ground. Earth fissures are dangerous because they can open spectacularly by trapping surface flows from rainfall and snow melt. Polygonal cracks are a network of polygonal shaped cracks of limited depths (not as deep as earth fissures).

The prediction of the land subsidence from groundwater decline has received considerable attention and various mechanisms for earth fissure formation have been proposed. The numerical prediction of land subsidence is based on either Terzaghi’s one dimensional consolidation theory embodied in Mudflow or modification to it using Biot’s three dimensional consolidation theory. However, consolidation theories do not include any failure criteria, so they are incapable of predicting the initiation of earth fissures.

The objective of this paper is to discuss a few key issues in modeling land subsidence and earth fissure as coupled consolidation-failure problem. The need to couple volume changes in the soil with its shear strength is explored. A new mechanism for earth fissure formation, based on the development of flexure and simple shear, is proposed. This is in contrast to the existing popular mechanism for the development of earth fissures based on the development of lateral tensile strains similar to those on the tensile face of a bending beam. A finite difference numerical scheme (FLAC-2D) simulating the soil by the Cam Clay and Mohr-Coulomb models is used to predict land subsidence and the initiation of earth fissure. The analysis reveals that shear strains are mainly responsible for formation of earth fissures.
A SYNTHESIS OF LAND SUBSIDENCE AND EARTH FISSURES IN THE APACHE JUNCTION-HAWK ROCK AREA

Muniram Budhu, Professor, Department of Civil Engineering & Engineering Mechanics, University of Arizona, Tucson, Arizona, 85721, Ibrahim Adiyaman, Research Assistant, Department of Civil Engineering & Engineering Mechanics, University of Arizona, Tucson, Arizona, 85721, Robert Babbitt, Research Assistant, Department of Civil Engineering & Engineering Mechanics, University of Arizona, Tucson, Arizona, 85721, Peter Kandaris, Senior Principal Civil Engineer, Salt River Project, 998 West Washington St., Tempe, AZ 85281, Raymond C. Harris, Consultant, 4051 N. Via Nueva, Tucson, AZ 85750

Since the early 1970s, the land within the Apache Junction-Hawk Rock (AJ-HR) area near Phoenix, Arizona, has been subsiding due to groundwater withdrawal and several earth fissures have developed. Consultant firms, federal, state and local governments, have conducted various studies for specific purposes such as mapping earth fissures or for construction of infrastructural facilities. The purpose of this paper is to present a synthesis of the various studies to help in the understanding ground displacements and soil fracturing from groundwater withdrawal and/or recharge.

The AJ-HR area has experienced a wavy pattern of ground displacements (land subsidence and uplift) due to differential ground displacements from local geology, groundwater well configuration, pumping rates and recharge. The gradient of the ground displacements rather than the total displacement is a key factor in the formation of earth fissures because they induce shear stresses on vertical planes in addition to bending stresses. With ongoing population growth in the AJ-HR area further demands will be placed on groundwater. Consequently, the rate of land subsidence, earth fissure development and growth may increase.

STOCHASTIC MODEL TO ESTIMATE TRAVEL TIMES FROM THE 52ND STREET FACILITY, PHOENIX, AZ


A stochastic approach varying hydraulic conductivity based on a two-dimensional, flow and advective transport model using the codes MODFLOW and MODPATH was used to estimate travel times in the alluvial aquifer from the former Motorola 52nd Street facility (Courtyard), Phoenix, AZ to the Frazee Deer-O wells near 24th Street and to the Operable Unit 2 (OU2) capture zone. The model results demonstrate that contaminant sources other than the 52nd Street facility are required to explain the observed contamination at the Frazee Deer-O wells (and at wells further west) because a source at the 52nd Street facility could not have resulted in contaminant migration to this area by 1983-1986, when trichloroethene (TCE) concentrations were first observed. In addition, the model results demonstrate that contamination from a source at the former 52nd Street facility could not have migrated into the OU3 area before the start up of the OU2 remedy.

SO YOU SAY ALTERNATIVES ARE THE ANSWER … LET’S TALK

James R. Burnell, Minerals Program Director, Colorado Geological Survey, Denver CO 80203

Public support is growing for the development of energy generation from renewable sources. An aspect of renewables that is possibly unknown by many, however, is the hardware needs for these technologies. The infrastructure requires mined materials, including imported strategic and critical minerals. Silica, copper, gallium, indium, selenium, cadmium and tellurium are required for the dominant photovoltaic technologies. Silver and aluminum are necessary for “concentrating solar power” technology. Zinc, vanadium, platinum group metals, and rare earth elements are key components of power storage, hybrid vehicle, and fuel cell applications. All these materials must be mined. At present, the U.S. is woefully dependent upon import sources for most of these materials and demand is already squeezing the prices. Domestic sources must be found and developed if energy independence is to be achieved using alternative sources.
IS ARTIFICIAL RECHARGE OF TREATED EFFLUENT A SAFE LONG-TERM STRATEGY?

Frank Butterworth, Institute for River Research International
Kenneth Janecek, Citizens Water Advocacy Group
Edward Wolfe, Verde River Basin Partnership

Recently the USEPA has reviewed the characteristics of 7500 organic compounds that are in or are entering our drinking water in order to focus their future research. They screened 560 in depth and selected 104 for their top research priority. However, the magnitude of their task of evaluating these compounds is overwhelming. Important among these contaminants is a broad suite of endocrine-disrupting compounds (EDCs) that include natural or synthetic hormones as well as compounds that mimic hormones and may interfere with the operation of endocrine systems of aquatic animals or humans. Indeed, a growing body of evidence suggests that some aquatic organisms are adversely affected where treated wastewater is discharged into streams. Some adverse effects stem from newly synthesized chemicals that often are part our everyday uses such as the plasticizer bisphenol-A that has become so widespread it is now found in the urine of 93 percent of the population. The hydrophobic compounds can be removed by adsorption. Other EDCs such as the attention-deficit-disorder drug, carbamazepine, are "hydrophilic"; they prefer to stay in the water and will escape filtration.

Many Southwest communities such as those in the Prescott AMA are dependent on groundwater for their domestic water supply. In many such areas return of treated wastewater to local aquifers is a rapidly developing strategy to extend the groundwater supply. However, the treated wastewater returned to the aquifers introduces to the groundwater supply contaminants that are not eliminated by standard wastewater treatment procedures. Prescott Valley, recently awarded "first-in-the-US" for its effluent auction, will be using, like nearby Prescott, all its recoverable effluent for recharge to augment its finite groundwater resource for new development. The City of Prescott's wastewater treatment plant has a special tertiary nitrification-denitrification, biological process that removed 89% of estrogen during recent EPA tests. The city of Chino Valley proposes a moratorium on new outside water connections which will assure at least 80% recovery of municipal delivery as wastewater. Although little is known about how passage to and through an aquifer may affect these contaminants, it is unequivocally clear that continuing recharge of wastewater will eventually send the discharged wastewater to the wells that supply domestic water and the springs that discharge ground water to streams. Repeated recycling of effluent may increase contamination with each pass much like re-use of agricultural irrigation water increases dissolved solids. Important questions need to be answered to assure that we are not irrevocably polluting our groundwater. However the problems, which are largely cost-related, appear unsolvable. The presentation will elaborate on these points to build a case that this issue deserves attention, will attempt to outline a logical sequence of questions that should be addressed, will identify groups that are working on the issues, will recommend existing monitoring technologies, and will suggest wastewater or potable water treatment processes that might be prudent and conservative to add now.

INFORMATION FLOWS AND POLICY: USE OF CLIMATE DIAGNOSTICS AND CYCLONE PREDICTION FOR ADAPTIVE WATER-RESOURCES MANAGEMENT UNDER CLIMATIC UNCERTAINTY IN WESTERN NORTH AMERICA

Ashley Coles, Department of Geography and the Udall Center for Studies in Public Policy, University of Arizona, Tucson, AZ

Climate variability and its impacts on human activities and economic growth complicate water management decision-making. Water managers in arid regions such as western North America must consider variability when addressing climate-related risks and vulnerability that arise from: a) exposure to weather extremes such as drought or cyclones, b) growing populations and increasing water demand, and c) agricultural production risks.

This research is part of a bi-national effort to provide users ranging from individual farmers and ranchers to municipal water providers with climate information that improves capacity to make critical water-management decisions amid shifting weather conditions, long-term climate variations, and changing social and economic conditions. We specifically address how users currently access and use climate information to make decisions about water use and allocation, as well as how to identify and improve access to potential alternative climate information sources. For the region of study, which is comprised of the southwestern United States and northwestern Mexico, agricultural production relies primarily on irrigation that depends on the frequency, duration, and intensity of rainfall associated with tropical cyclones and the North American Monsoon. This study links vulnerability and institutional analyses to identify where climate and economic considerations intersect within decision-making strategies, and how climate information may be provided according to users’ needs in order to improve their ability to effectively manage water resources.

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CHATTANOOGA CREEK SITE NAPL AND CREOSOTE REMEDIATION
UTILIZING AQUABLOK® LOW PERMEABILITY THIN CAPPING APPROACH

John Valkenburg, Adventus Americas, Inc.

Significant non-aqueous phase liquids (NAPLs), coal tar and creosote are present at a site in Chattanooga, Tennessee as the result of historic manufacturing activity. As the site abuts a low, marshy natural area, which includes oxbow remnants of the former creek channel, it is an area of significant natural resource value with planned future use as a component of a park system. Because all upland control of the sources has not been secured, Chattanooga Creek is subject to ongoing impact from contaminants. To mitigate this impact, AquaBlok was selected as a natural low-permeability, clay-based liner material to limit further migration of contaminants into the creek system, which empties directly into the Tennessee River and to facilitate the restoration of the oxbow area as a beneficial natural feature.

Installation of the remediation approach was initiated in the fall of 2006 and a second phase was completed in the summer of 2007. The presentation will provide a site overview, and extensive practical information on installation, handling and quality control aspects of the selected remediation solution.

The presentation will provide an overview of the objectives and results of the installation. An overview of site related challenges and goals that limited the acceptance and applicability of alternative measures will also be discussed. The regulatory perspective will be presented together with comments on the applicability of the method selected to other similar sites.

THE IMPORTANCE OF GEOLOGIC INFORMATION IN TRENCHLESS TECHNOLOGY: INFORMATION REQUIRED, RESPONSIBILITIES OF THE GEOLOGIST, AND ETHICAL ISSUES

George H. Davis, R.G., CPG-10951, Geologist, Missouri Department of Transportation, Jefferson City, MO

Trenchless technology is the phrase that denotes the equipment, supplies, and methods used for the installation, replacement, or renewal of subsurface utility product pipe without the primary use of a trench. The methods, equipment and supplies of trenchless technology offer a means of minimizing surface disturbance with utility installations. The use of trenchless methods of utility installation, replacement or renewal has the added bonus of decreasing installation costs in the long term. Methods of pipe installation, pipe replacement, pipeline renewal and pipeline inspection have been increasingly perfected in the last ten years. This allows trenchless methods of pipe installation, such as horizontal directional drilling (HDD), to be competitive with open-cut installation. It should be emphasized that the use of trenchless technology drastically reduces or eliminates the possibility of trench accidents that annually cause injury and deaths in the United States.

Most geologists are unfamiliar with these methods, the technology used, and the need for geologic input in the design process that precedes new installations. One method of trenchless utility upgrade, pipe bursting, requires geologic information for an upgrade to be successful. If pipe bursting is attempted where the original installation was made in a rock trench, the pipe burst may be impossible, or pressures may cause surface heaving. Geologic information may also be required for pipe relining where a structural pipe liner is used. The overlying weight of the soil on the utility product pipe should be known so that a pipe liner may be chosen of sufficient strength to perform the upgrade. Knowledge of soil conditions may also affect manhole renewal, and is essential for upgrade by pipe reaming.

The importance of geologic and soils map relationships used to plan a proposed utility installation’s alignment cannot be understated. Normally, three parameters are considered in advance of an installation: the depth of the crossing to be made, the length of the crossing, and the type of product pipe to be used. If critical information is not interpreted correctly or ignored, problems of installation may result that can lead to cost overrun, or even termination of a boring. This information is essential for the owner to insure a successful boring and for the contractor to realize profit from the bore. Here, it is proposed that a fourth parameter also be considered in advance: the type(s) of geology and soil(s) present in the path of the crossing. Additionally, the degree to which a soil varies between entry and exit should be characterized to an acceptable degree of statistical certainty for contractor bidding purposes. Determining the geology in advance of the installation allows tooling and even method choices to be chosen with sufficient confidence to decrease bid price. Issues of soil reactivity with certain types of pipes may also be addressed in advance, enabling the most suitable pipe to be chosen for an installation, or a protective coating may be applied.
E-LEARNING: USE OF GOOGLE EARTH FOR GEOLOGICAL INFORMATION
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Geologic maps are essential for the understanding of the environment, avoiding risks related to geologic hazards, and for proper management of resources. “Google Earth” is a modern and free accessible tool that can be used to visualize geological data based on geographical information. It also provides the option to define geological maps as overlays. This system can be used to develop interactive maps, which provide significantly more information than a printed version ever could.

Distance learning is the online form of education where tutors and participants interact with each other via Internet. All the course materials such as tutorials, interactive questions catalogues, forums, assignments, and other exchanges happen technologically, aided by modern communication means and computer equipment. Distance learning permits the interaction between participants either in real-time or asynchronously independently from different locations.

Currently, an online course using Google Earth is available, focusing on the definition of placements and overlay maps that contain geological information. Course participants can learn how to use Google Earth for this purpose and for publishing geological data in a KMZ file of Google Earth by using a Web server.

APEGBC 2010
TOWARDS A FRAMEWORK FOR PROFESSIONAL RENEWAL
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APEGBC 2010
Towards a FRAMEWORK FOR PROFESSIONAL RENEWAL

Ten Characteristics of Self Regulation professions
1. Proactive in the public interest
2. Legislative Duty and Code of Ethics
3. Education, experience, and examination requirements for entry
4. Guidelines and practice standards
5. Practice reviews and performance
6. Compliance monitoring, investigation, and discipline
7. Enforcement
8. Continuous professional development
9. Specialist designations
10. Transparency

March 2008
HOW TO IMPROVE WELL EFFICIENCY AND WELL YIELD TO SAVE MONEY

Charles W. Drake, PG, CPG, Tetra Tech, Orlando, FL

In many parts of Florida, the addition of new wells that tap into “traditional” groundwater supplies has become very difficult. It is critical that utilities maintain the most efficient wells possible to avoid having to go to more costly alternative water supplies. In these days of budget reductions, it is critical to have the most energy efficient water production facilities possible. The first place to do this is at each water supply well. A properly designed and maintained well can efficiently provide water throughout its design life. An improperly designed and maintained well will have excessive drawdown, low yield, high energy costs, and create an unnecessary need for additional wells.

Proper design of a water supply well, either screened or open hole, is critical to maintaining long term production and efficiency. An efficient well is one that produces the least amount of drawdown in the well at a given pump rate, such that the specific capacity is as high as possible. When drawdown is minimized and specific capacity maximized, the cost to pump water is reduced. Annual or periodic maintenance will prevent biofouling, mechanical fouling, and/or mineral encrustation from reducing well efficiency and yield. It is crucial to collect sufficient hydrogeologic data on the producing aquifer to design the well and pump setting such that the well is as efficient as possible. Necessary hydrogeologic data includes aquifer thickness, groundwater quality, permeability, transmissivity, storage, and leakance of confining units. In areas not adequately tested, exploratory wells should be constructed to collect the necessary hydrogeologic data; then, and only then, can an efficient well be designed.

Monitoring of monthly pumping and static water levels along with pumping rates should be maintained in order to track the performance of the well. If the specific capacity of the well declines over time, screen plugging or encrustation is indicated. Well rehabilitation can be accomplished by redevelopment, acidization, or chemical or mechanical cleaning. Case studies for these issues along with examples of rehabilitation and increases in performance and efficiency are provided in the paper.

LOWER FLORIDAN AQUIFER ALTERNATIVE WATER SUPPLY EXPLORATORY PROGRAM

Charles W. Drake, PG, CPG, Tetra Tech, Orlando, FL

The Toho Water Authority (Toho) is the largest water supply utility in Osceola County, Florida and has projected water demands of over 70 million gallons per day, in 20 years. This represents 40 MGD more than that which is pumped today. Toho is also in the recently promulgated “Central Florida Coordination Area,” which requires that all potable water demands above those currently permitted cannot be met by traditional sources, and must be met by an alternative water supply (AWS). In central Florida, traditional sources are fresh groundwater from the Upper Floridan aquifer system. As defined in 2007 by the Florida legislature, alternative water supplies are: fresh or brackish surface water, brackish groundwater, stormwater, seawater and reclaimed water.

Being an inland utility, the use of seawater or significant quantities of surface water is not economically feasible. To date, no central Florida utility has developed a brackish groundwater supply from the Lower Floridan aquifer. The Lower Floridan aquifer has been identified as an alternative water supply, and will meet the CFCA rule.

TWA has embarked on a nearly $10 million Lower Floridan Exploratory Well Program to determine the quality of water in, the water bearing capacity of the Lower Floridan aquifer, and potential injection zones for concentrate disposal at depths from 1200 feet to 2600 feet. Large diameter test wells, 8 inch to 12 inch, and 8 inch diameter monitor wells were constructed into the Upper and Lower Floridan aquifers and aquifer performance tests were conducted in each aquifer. Packer tests were conducted, along with drill stem tests, to determine water quality with depth. This multi-million dollar program willguide their potable water supply options over the next 20 years.

PROFESSIONAL GEOLOGIST REGISTRATION/LICENSURE IN THE UNITED STATES – A SUMMARY

Rick L. Ericksen, President, Division of Professional Affairs/AAPG and Executive Director, Mississippi State Board of Registered Professional Geologists

There are currently 29 states and one (1) territory that have enacted true practice regulation laws in the United States. Since the beginning of this decade the states of Texas, Utah, and Tennessee (new legislation effective January 1, 2008 changing the existing legislation from a title regulation act to a practice act) have implemented legislation requiring that those publicly practicing geology must be registered/licensed in order to practice their profession. Over this same time frame several states, including Colorado, Hawaii, Oklahoma, Michigan, and New York, have legislation pending or have introduced legislation that
failed to be enacted. Common to all of the states that have implemented geologic registration/licensure laws, and are no longer “grandfathering” geologists, is the general requirement that all those not subject to an existing comity/reciprocity agreement must take and successfully pass the two National Association of State Boards of Geology (ASBOG) examinations, the Fundamentals of Geology (FG) and the Practice of Geology (PG).

Geologic practice exemptions vary from state to state that generally cover the spectrum of academia, government employees (state and/or federal), subordinates, research, and resource geologists. Generally the following exemptions are common in many registration/licensure laws:

1. Geologic work performed by an employee or a subordinate of a license holder if the work does not include the responsible charge of geologic work and is performed under the direct supervision of a licensed geologist who is responsible for the work;
2. Geologic work performed by officers and employees of the United States practicing solely as such officers and employees;
3. Geologic work performed exclusively in exploring for and developing oil, gas, or other energy resources, base metals, or precious or nonprecious minerals, including sand, gravel, or aggregate;
4. Teaching in geology or related physical or natural sciences, except for teaching in any specialty of geology affecting the public health or safety;
5. Geologic research conducted through academic institutions, agencies of the federal or State governments, nonprofit research institutions, or for-profit organizations, including submission of reports of research to public agencies;
6. Work customarily performed by a physical or natural scientist, including a chemist, archaeologist, or geographer, if the work does not include the public practice of geoscience;

It is significant to note that with reference to resource geologists the Suggested Geologist Practice Act of 1993 (also known as the Council of Professional Geologic Organizations or COPGO bill) does not exempt resource geologists per se but rather leaves the registration/licensure board to develop regulations/rules governing that facet of professional practice. An example of another variation of legislative language related to this sector of professional practice is contained within the adopted Texas legislation that states “…geologic work performed exclusively in exploring for and developing oil, gas, or other energy resources, base metals, or precious or nonprecious minerals, including sand, gravel, or aggregate, if the work is done in and for the benefit of private industry…”

Other general and state specific registration/licensure laws will also be discussed including matters related to the authorities granted to registration/licensure boards to carry out investigations, impose disciplinary actions, and levy fines for infractions ranging from ethical violations, unlicensed practice, competency issues, and related matters.

**FIVE POINTS OF PROFESSIONALISM – PROFESSIONALISM, CERTIFICATION AND CONTINUING DEVELOPMENT IN ENERGY RESOURCE GEOSCIENCE**

**Thomas E. Ewing, DPA-AAPG, San Antonio, TX**

Professionalism includes five key points:

1. We are trained and skilled to an industry standard.
2. We are trusted by our clientesles (the public and the industry).
3. We stand by our work.
4. We know when a matter is beyond our expertise, and refer to other professionals.
5. We live in the community of professionals, and carry forward a tradition

Under point 4, we have a responsibility to know our limits and not represent ourselves falsely as expert in geoscience specialties. But as geoscientists, we need to keep ourselves fresh so that we can work to an evolving ‘industry standard’. And we would like to expand our areas of competence. We can think of four categories along a spectrum:

Category 1. on one end, is our “professional competence”. We still need to keep this fresh, but we would be qualified to teach a course in this material.

Category 4. at the other end, is the unknown but knowable world. If we hear about capabilities that might be important to us, we promote them to Category 3.

Category 3 is the fringe of our knowledge. As we grasp the essentials of the topic, and we see how it can be applied, this material moves gradually to Category 2.

Category 2 is the penumbra of our competence. How do we take the last step and really make it a true professional competency? Mentoring and apprenticeship.

Working and learning.

Oversee a contractor.

Most one-day short courses and talks take the participant from Cat-3 to Cat-2. Only a week-long workshop course has any hope of advancing to Cat-1, although a year-long apprenticeship would be better.
PREDICTING SUBSIDENCE – I'VE GOT A SINKING FEELING
Kenneth Fergason, P.G., AMEC Earth & Environmental, Inc., Tempe, AZ, Michael Rucker, P.E., AMEC Earth & Environmental, Inc., Tempe, AZ, Ralph Weeks, P.G., AMEC Earth & Environmental Inc., Tempe, AZ

The depletion of groundwater resources in several deep alluvial basin aquifers in the Western U.S is causing ground subsidence. Our ability to predict the future rate, distribution and magnitude of this subsidence is limited by several key factors. The mechanics of the subsidence process are not well understood, and our knowledge of the geological properties and behavior of the aquifer sediments is often quite limited. Both simplified and complex models that simulate future subsidence can and have been developed, but often have significant limitations due to the assumptions that must be made. Whether dealing with a basin-wide or localized subsidence prediction, the level of characterization necessary and the understanding of basin characteristics needed are often far in excess of the information available or obtainable. Answering such questions as what are the pre-consolidation conditions, what affects does past subsidence have on future subsidence, what are the physical properties of the affected subsurface layers, pose distinct challenges as the need to accurately predict subsidence increases.

Quantifying future groundwater withdrawal is an equally difficult issue related to predicting subsidence. Depletion of the aquifer water table resulting from excessive groundwater withdrawal drives the subsidence process, and in order to predict future subsidence, you must first be able to predict future groundwater withdrawal. Further complicating the issue of groundwater withdrawal prediction is the degree to which it is dependent on socio-political issues as well as uncertainties such as normal climatic fluctuations and long-term climate change.

What will the population patterns be in 50 years? What will their water needs be? What will be the sources of that water? In 50 years, what will be the balance of agricultural versus residential/industrial water use? What will be the impact of further residential and commercial developments and their ‘100-year assured water supplies’ when they fail to account for one another and other realities of geo-political and water supply change? What will be the impact of relatively unregulated rural water use? How will the climate fluctuate in the next 50 years? Are we experiencing the beginning of a long-term drought? What does long-term climate change hold in store for water supplies? To develop a means to predict and subsequently manage subsidence, all these factors create a formidable challenge.

THE GEOTRAINET PROGRAMME
I. Fernandez Fuentes, EFG, H. Ligtenberg, Shell Oil Co., The Netherlands, G. Ll. Jones, Institute of Geologists of Ireland

The European Federation of Geologists is the Co-ordinator in a large group which has made a successful application to the European Commission for a grant to run a programme for the training of professionals to install ground source heat pumps across Europe. The group consists of: European Federation of Geologists, European Geothermal Energy Council, University of Lund Sweden, GT Skills Ireland, BRGM France, Romania Geoxchange Society, Arsenal Research Consultancy Austria, Newcastle University UK, National Association of Renewable Energy Producers Spain, BAU-ABC Rostrup Germany, Universidad Politécnica de Valencia.

The programme is called GEOTRAINET which in full is “Geo-Education for a sustainable geothermal heating and cooling market”. The aim is to develop the training of professionals involved in a Ground Source Heat Pump project. From the different groups of professionals involved in a GSHP, the GEOTRAINET project is focused on two target groups: designers (feasibility study including geologists) and drillers (who make the boreholes and insert the tubes).

The objectives are to: Improve quality of work and design of ground source heat pumps; Establish expert platform on geosciences and installation; Creation of teaching tools; Investigate and define standards and codes necessary for GSHPs; Formulating a EU certification framework; Launch a first European certification campaign for rapid market penetration of GSHP, targeting key professional groups; Assist European Commission with wider dissemination activities, according to Commission requirements; Sustain the growing market.

AIPG’S SYSTEM OF ONLINE INSTRUCTION – A PORTAL TO GLOBAL GEOSCIENCE
Robert Font, CPG 3953, AIPG, Geoscience Data Management, Plano, TX

Fulfilling continuing education requirements and proper reporting and accountability procedures have become essential for many of us licensed and certified geo-professionals. Thus, providing accessibility to accredited and affordable online courses in the geological sciences can result in an extremely valuable service to geoscientists across the globe.
Through several years of cooperation and based on the effort of both members of the AIPG and the EFG (e.g., Dr. Robert Font, President-Geoscience Data Management, Inc. and Dr. Detlev Doherr, Dean and Professor-University of Offenburg, Germany), a new online system of instruction is currently available through the AIPG. The system is elegant, user-friendly and has many built in "bells and whistles" to make it an attractive and practical tool for anyone who wishes to use it.

Four courses are currently available via the system (“Introduction to Landslides and Mass Wasting”, “Practical Petroleum Geoscience”, Introduction to Well Logs and Log Analysis for New Hires” and “The Basal Cretaceous of North Texas – A Virtual Field Trip”). Geoscience instruction on almost any subject and on about any level can be formatted as online offerings. Possibilities for developing instructional materials are nearly endless. Optimum communication and learning can be achieved on one’s own time schedule, regardless of where one is physically located globally, as long as Internet access is available.

Based on the experienced gained in developing several of these online offerings, the following are offered as suggestions for course development:

- Convey the material as effectively as possible in the selected format (e.g., slides, tables, and text documents), using color fonts and figures wisely to relay critical information and aid the student in the actual learning process.
- Make the course a self-contained product. Do not burden the learner with having to access a plethora of outside references in order to follow the material being presented. Provide references and outside readings for anyone desiring to expand their knowledge beyond the online course.
- Develop internal review questionnaires to help the students recognize and emphasize the most critical points.
- Use formulae wisely, highlighting the key points or concepts in the main body of the presentation, saving derivations and details for appendices. If the course involves various chapters and several appendices, consider attaching the corresponding appendix at the end of the proper chapter for continuity of thought and convenience of the student.
- Update the material as time goes by. Keep the offering current in its content and applicability.

To this point, efforts have been focused in targeting the fulfillment of CEU credits for practicing geosciences professionals. However, it is evident that this vehicle can also be used to convey valuable information to others non-science professionals. Examples may include:

- Realtors and insurance professionals.
- Engineers, soil scientists, environmental (non-geoscience) professionals, mathematicians, physicists and chemists.
- Accountants, attorneys, politicians and legislators.
- Students (K-12 through University) and the general public

The range of possible topics that can be covered is basically limitless. The versatility of the online system makes it a superb tool for specialized coursework with rigorous, in-depth coverage, as well as for introductory, survey-style offerings.

With the system in place, running and with offerings available at an attractive cost to the consumer, we must now wait to gauge its success. The latter depends almost entirely on the value of the service it may provide. If the market exists for these courses, success is certainly assured and continuing contributions by experts in their respective fields are obviously essential.

TWO EXAMPLES OF QUANTIFICATION OF SUBFLOW ZONE DEPLETION IN ARIZONA


An issue not yet considered by the Court in the Arizona Gila River Adjudication is the magnitude of depletion to the Subflow Zone (appropriable ground water) by a well located within the lateral limits of the Subflow Zone and completed in an aquifer that is vertically separated from the Subflow Zone. In Arizona, only the portion of the well pumping that causes water to leave the stream, or is connected to the Subflow Zone, is considered stream depletion. The Subflow Zone is defined by the extent of the saturated Holocene floodplain alluvial deposits; practically, the vertical extent includes all Quaternary floodplain deposits.

MODFLOW 2000 was used to quantify the Subflow Zone depletion for two groups of wells located along the Verde River. The two groups have differing aquifer properties so two models were created. Both models contain separate layers for the Subflow Zone, aquitard, and deeper aquifer. The models were calibrated to a regional potentiometric surface map, and a series of water levels measurements. Drillers’ logs were used to map the thickness and lateral extent of the aquitard.

Quantification considered the pumping rate of the wells, the potentiometric gradient of the deeper aquifer (Verde Formation), the lateral extent of the aquitard along with the hydrogeologic properties of the Subflow Zone, the aquitard, and the deeper aquifer. The analysis also considered the impact of each of the wells separately and grouped together. The depletion, expressed as a percentage of the pumping rate, ranged from less than one percent for wells located at the edge of the Subflow to more than 83 percent for a well located near the Verde River.
We conclude that the Subflow Zone depletion is most sensitive to the pumping rate, to the location of the well between the river and the outside limit of the Subflow Zone, to the transmissivity of the deeper aquifer, and to the potentiometric gradient of the deeper aquifer. The depletion is less sensitive to the transmissivity of the Subflow Zone and the transmissivity of the aquitard.

TRIBAL LEADERSHIP AND INFLUENCE IN ADDRESSING WATER RESOURCE ISSUES IN WASHINGTON STATE: EXAMPLES OF TRIBAL ENVIRONMENTAL SUCCESSES THROUGH PARTICIPATION IN WATERSHED AND WATER RESOURCE PLANNING PROCESSES

David R. Fuller, CPG, LG, LHG, PG, Port Gamble S’Klallam Tribe, National Resources Department, Kingston, WA

The twenty-nine Tribe’s in Washington have lived in the Pacific Northwest for many thousands of years. Treaties between the Tribes and the United States were signed and ratified by the U.S. Congress in the mid 1800’s, ceding millions of acres of land for non-Indian settlement and enabling Washington to become a state. The Tribes moved to smaller federal reservations, while retaining their legal right to hunt, fish and gather in their usual and accustomed areas (U&As). These are inherent, treaty-protected rights that remain as valid today as the day they were signed. However, decades of neglect by the State and Federal governments and their avoidance and interference with of Treaty-protected and reserved fishing, hunting and gathering rights led to many years of expensive litigation and several U. S. Supreme Court rulings reaffirming the treaties. These 120 years of governmental inaction, avoidance and repression, coupled with rapid land use development, has left the Tribes’ Reservations and Usual and Accustomed Areas with many impacted surface and ground water quality and quantity issues. These individual and collective issues directly threaten all tribal and non-tribal water dependent resources, as well as tribal subsistence and commercial species, such as salmon and shellfish.

In recent years, the Tribes have translated these legally reaffirmed rights and authorities into positive environmental actions. Leveraging Environmental Protection Agency grant funding (available to Tribes beginning in the 1990’s) and other funding sources, Tribes have been building their environmental capacity to address their water resource needs. A unique aspect of Tribal water resource visioning and planning is the concept of looking out seven generations (approximately 150 years). In other words, we, the scientific and technical staff, have been directed by our Tribal Governments to look at protection and sustainability of the resource, not only in the near-term, but for their grandchildren’s grandchildren and beyond. This concept requires a greater and more holistic view of the water resource status and trends, as well as climate change and watershed impacts, than current land-use planning. To work toward achieving this more holistic vision, Tribes have provided scientific and technical leadership while participating with State and local governments in regional watershed planning and water resource protection efforts.

The Tribes’ scientific and technical capacity building efforts have led significant positive environmental successes through participation and leadership in local and regional water resources and watershed planning processes. Tribal participation in regional water resources planning and protection efforts has led to the recognition of the extent of Tribal monitoring, data collection, and scientific analysis underway in Indian Treaty areas. In Washington State, Tribes have a greater environmental presence than most cities, counties or the State combined. Tribes have been able to provide better data and more complete information to help make more informed decisions on regional water resources issues for their environments.

The Coordinated Tribal Water Quality Program (CTWQP) was developed through the Northwest Indian Fisheries Commission as an informal group of Tribal professional and technical staff from the Washington Tribes to provide better intertribal coordination and collaboration on water quality issues. The CTWQP actively encourages and facilitates intertribal data sharing, technical communications and scientific research for and among the Tribes for the improvement of water quality and quantity in the State of Washington.

In addition to regional and watershed planning efforts, the Tribes have leveraged funding and partnerships for watershed, habitat and stream restoration projects, as well as toxic cleanup efforts. A key focus for the Tribes has always been the sustainability of their cultural traditions, such as, subsistence hunting, fishing and gathering. Protection and restoration of Treaty protected and affirmed resources have led to more concentrated water quantity and quality monitoring. Significant Washington Tribal surface water quality efforts and government-to-government collaboration with the U. S. Environmental Protection Agency resulted in Washington State surface water quality standards that better protected listed and endangered salmonid species through better scientifically based water quality and fisheries data.

Water quantity and the issues of State water rights versus Federally-reserved water rights have been a challenging issue. Protection of in-stream flows for listed and endangered species, while maintaining sustainability of potable water supplies for Tribal and non-Indian communities has locally led to some creative environmentally protective incremental State water rights. Creatively and pragmatically addressing the sustainability of water resources, within a “seven generations” forward looking...
approach that is responsive to the reality of global climate change, expanding populations, urban sprawl and land-use practices, are among the most important water resources issues the Tribes are actively reviewing and discussing.

OVERVIEW OF INTERNATIONAL MINE CLOSURE GUIDELINES
Dawn H. Garcia, CPG-08313, SRK, Tucson, AZ

The mining industry has learned that plans for closure of mine and plant facilities, plus post-closure use of the land, must be presented to stakeholders as part of a successful planning process and to obtain the “social license” from the community. Historic mining operations that were abandoned without closure methods that mitigated physical and environmental impacts have negatively influenced the ability of mining firms to obtain a social license. The perception that a new modern mine will create the same impacts during operation and at closure as abandoned historic operations must be overcome during the initial steps of an exploration program. The closure planning begins during project conception.

Mining companies typically conduct exploration projects in far-reaching corners of the globe, in countries with varying governmental regulations and standards for mine closure. What guidelines should be considered as basic references for a closure plan for operations in any country? In the absence of well-defined closure regulations, companies may choose to use closure guidance from international sources such as the World Bank and the International Finance Corporation, as well as prominent national and state or province specific legislation. Corporations can compare published guidance documents to develop a “baseline” list of closure elements, and subsequently use a risk-based corporate analysis to refine the closure approach.

The most elementary goal of closure is to minimize future environmental impacts from mining activities and to reduce future financial risk to the company’s shareholders. All aspects of the environment, such as soil, water, air, and communities, are considered during closure planning. National and local legislation may provide specific closure design requirements and regulatory standards for soil and groundwater. A risk-based strategy also considers the potential future risks and how much risk the company is willing to incur. Risks can be reduced by removal of impacted materials or by in-place remedial closure methods. The long-term post-closure care and maintenance, especially those associated with impacts from closed facilities, need to be considered in the closure strategy and demonstration of responsibility for a social license.

CESSATION OF FLOW IN THE PEACE RIVER – THE HAWTHORN AQUIFER SYSTEM CONNECTION, POLK COUNTY FLORIDA
Michael T. Gates, P.G., Southwest Florida Water Management District, Tampa, FL

Results from a recent hydrogeologic investigation along the Upper Peace River in Polk County, Florida indicate a direct hydraulic connection exists between the Peace River and the Hawthorn aquifer system (also known as the intermediate aquifer system). The Peace River supplies 23 megaliters of water per day to residents in the Peace River basin. Streamflow in the upper Peace River has been declining for decades. The complete cessation of flow in the river between the cities of Bartow and Homeland was first documented in 2000. The perennial loss of river flow through karst features in the flood plain has primarily been attributed to the gradual decline of the potentiometric surface of the Upper Floridan aquifer. The Upper Floridan aquifer is the primary source of potable supply and natural springflow in the state of Florida. The Hawthorn Aquifer System separates the Peace River from the underlying Upper Floridan aquifer. The data from this study indicates the connection between the Peace River and the underlying Hawthorn aquifer system may be a significant factor affecting streamflow.

Hydrogeologic testing was performed at three sites adjacent to the Peace River. Wire-line coring was conducted to collect lithologic samples and to delineate the permeable and confining units. Down-hole inflatable packers were used while coring to conduct in-situ slug tests. The slug tests were analyzed to help define the permeable zones and confining units and to assign hydraulic conductivity values to each. Monitor wells were constructed at each site and aquifer performance tests were conducted on the Hawthorn aquifer system and the upper portion of the Upper Floridan aquifer at two of the three sites.

Analysis of the data collected during the study confirms the heterogeneous nature of the Hawthorn aquifer system. An upper Arcadia aquifer and lower Arcadia aquifer were identified during the study. Transmissivity values for the Hawthorn aquifer system obtained from aquifer tests at two sites approximately 5.6-kilometers apart varied by nearly two orders of magnitude. The data also shows the upper Arcadia aquifer is in direct connection with the Peace River through karst features.

GIS DATABASES AND MAPPING: TOOLS FOR WATERSHED MANAGEMENT, LAKE TUSCALOOSA, CITY RESERVOIR
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Lake Tuscaloosa is the reservoir for the City of Tuscaloosa’s drinking water supply and is also a significant public recreation center. This water supply source provides water to the City’s expanding customer base and twelve area water authorities served by the City. The Lake, completed in 1970, was developed by constructing a dam across North River. Lake Tuscaloosa consists of 2,382 hectares (5,885 acres) with a full pool capacity of 151 billion liters (40 billion gallons) of water. The water drawn from the Lake is treated and meets or exceeds the national standards for public health.

The City has recently completed a detailed land use assessment of about 22,000 hectares (85 square miles) of the watershed. The interpretation of land use was completed on a parcel-by-parcel basis. Fifteen specific land use categories were utilized and a category was assigned to each of the nearly 7,000 parcels evaluated. The coded land use category for each parcel was entered into the GIS geodatabase. In addition to land use, other databases including septic tank registration, permitted piers, permitted boat houses, marina fuel tanks, and water-quality sampling locations have been included in the geodatabase. The specifics of the water-quality data and lake bathymetric information are being built into the geodatabase.

The databases are being updated and expanded on an on-going basis. The mapping, interpretation of mapping components, and the testing data are part of the City’s ongoing efforts toward protection and preservation of Lake Tuscaloosa. These tools are being used to support implementation of City policies and ordinances relative to zoning, conservation, and land development, and the adoption of new policies and ordinances; educational outreach for the general public about the programs, policies, ordinances, and regulations that pertain to activities within the watershed; monitoring and enforcement; and the basis for and development of supplemental testing programs and additional investigations.

WOMEN IN GEOLOGY IN SPAIN


The wish and the struggle to build academic and professional models which we can refer to in the wide social panorama we face, is today, in the XXI century, a challenge and homage to all those pioneer women geologists which with effort and tenacity busted the social barriers which were then deemed unbreakable.

But today women geologists, like the rest of women, have different working conditions than men. Recent studies on women and science show that the perception that women are less “visible” and discriminated against during their professional careers is real and can be demonstrated with data. Data from different sources and organizations indicate that women geologist participate less in decision-making committees and have more difficulties to reach the highest positions that their male colleagues. This occurs even considering that the number of women that finish their degrees in geology in Spain is higher than the number of men. Along their professional career there is an inversion, in which women geologist are “lost in the way” to top positions. In this paper, we present some data in order to call the attention on this situation and to bring to the table a discussion on the possible measures to correct this situation.

In general we can say that working conditions for women in Spain has the following rates:

- The unemployment rate of Spanish geologists (ICOG) is today 2.75 %. Male unemployment rate is 2.19 %. Women unemployment rate is 3.97 %.
- In 2002 out of the 50 better baccalaureates records in Spain, 37 (which represent 74%) were women, and out of the 183 career honours, 123 (67.2%) were granted to women.

In 2004 a total of 287 000 entrepreneur women were recognized in Spain, but the rate of women participation (Ratio women/men to the total entrepreneur activity TEA) is yet very low (0.39) when compared to the average of European countries (0.55).

In the case of Spain, the ratio women/man to the TEA of opportunity is 0.41, well over the TEA of necessity of 0.28. Such situation equals that of countries such as The Netherlands, Sweden and the USA, were women participation in the economic activity is traditionally higher. It is also over the average rate of Portugal, Germany and France.

The rate of female participation is higher in new companies where there are fewer obstacles to women due to a lack of a consolidated masculine opposition, and has a lower failure index, as women normally perform more cautiously and respecting norms.

“Now, more than ever, women cause is mankind cause” Boutros Boutros-Ghali
Mountain system recharge (MSR) is an important, if not predominant, source of groundwater recharge to alluvial basins in arid and semi-arid regions in the Basin and Range Province of southwest USA. MSR consists of mountain front runoff that infiltrates at the mountain front (mountain-front recharge [MFR]) and percolation through the mountain bedrock that reaches the basin via deep groundwater flow over longer time scales and flow paths (mountain-block recharge [MBR]). In Tucson basin, Arizona, the mountain system recharge mainly occurs at the mountain fronts of the Santa Catalina Mountains and Rincon Mountains, located at north and east of the basin, respectively. In this study, a suite of environmental isotopes was used to identify the locations of MFR and MBR, and distinguish these two recharge mechanisms in northeastern margin of Tucson Basin.

The results for oxygen ($\delta^{18}O$), hydrogen ($\delta^2H$), sulfur ($\delta^{34}S$), sulfate oxygen ($\delta^{18}O$-SO$_4$), tritium ($^3$H), and carbon-14 ($^{14}$C) isotopes and geochemical analysis suggested that mountain-block recharge is an important component of mountain system recharge; however, it is relatively limited in spatial extent.

Sulfur ($\delta^{34}S$) and sulfate oxygen ($\delta^{18}O$-SO$_4$) isotopes are extremely useful in identifying the locations of MBR and distinguishing between MBR and MFR. Groundwater samples from several wells and springs in the northeastern margin of the basin have $\delta^{34}S$ values ranging from 6.8 to 9.1 ‰, similar to the $\delta^{34}S$ values of gypsum samples collected from the Pantano Formation in the Catalina Foothills; however, their $\delta^{18}O$-SO$_4$ values can be further divided into two groups; the first group has $\delta^{18}O$-SO$_4$ values around 7.5 ‰, and the other has low $\delta^{18}O$-SO$_4$ values, ranging from -1.7 to 2.5 ‰. These low $\delta^{18}O$-SO$_4$ values suggest that the sulfate derived from oxidation of a reduced S source, mostly likely sulfide minerals in this case. When reduced S (such as sulfide) is oxidized to sulfate, 50 to 100 % of oxygen in the product sulfate is derived from local water, the amount depending on the oxidation environments and pathways (Van Stempvoort and Krouse, 1994).

These two groups of groundwater also have different water chemistry. In the first group, groundwater is of Ca-HCO$_3$ type. The second group is of Na-SO$_4$ type, and also has a high fluoride concentration (6 to 10 mg/L). The high sulfate concentrations in the second group also provides evidence of sulfate oxidation, and this sulfate is very likely derived from the oxidation of pyrite in gneiss or other bedrock in the Santa Catalina Mountains. High sodium concentrations in the fault zone are most likely due to alteration of plagioclase in the granitic gneiss.

The wells showing low $\delta^{18}O$-SO$_4$ values are completed in gneiss in the footwall of the detachment fault, and the springs are also located close to the Santa Catalina detachment fault. This type of water is limited in area extent. The spatial association of this type of water with the Santa Catalina detachment fault indicates that this water is possibly the product of deep circulation through faults and joints in the gneissic mountain block. This water here appears to be ponded/dammed by the Santa Catalina detachment fault, and might be expected to breach the fault locally, recharging basin sediments in the subsurface. This type of groundwater could potentially be detected using the low $\delta^{18}O$ values of the dissolved sulfate, particularly in area where the detachment fault in covered by a relatively thin layer of basin-fill sediment. This group of groundwater is identified as mountain-block recharge.

$\delta^{18}O$(H$_2$O) values in the water from this type of groundwater are nearly identical, -10.1 or -10.2 ‰, which is lower than groundwater samples from most other wells drilled in the Patano Formation or pediment alluvium in this area. These low $\delta^{18}O$(H$_2$O) values are similar to those of mean winter precipitation on the Catalina Mountains (Wright, 2001), indicating that the water originated as high-elevation precipitation, and with similar elevation ranges.

In addition, $^{14}$C data further confirm that this type of groundwater has similar flow paths, with $^{14}$C contents of approximately 30 pMC (percent modern carbon) and tritium concentrations below detection limit. Other groundwater in this area are originated from mountain-front recharge, and shows higher $\delta^{18}O$(H$_2$O), $\delta^{18}O$(SO$_4$), $^{14}$C values, and lower sulfate concentration in general. Most groundwater of this type also has detectable tritium concentrations.

This study suggested that MBR is mainly related to Catalina Detachment Fault, and has distinguished sulfate oxygen isotope signatures; which could be distinguished from MFR. This investigation further confirms that multiple isotopic and geochemical tracers can be used to constrain the sources and flow paths of groundwater in very complex alluvial systems.
The Glen Canyon National Recreation Area (GLCA) and the U.S. Geological Survey (USGS) established 20 monitoring sites on Lake Powell in 2004, to provide long-term and consistent water-quality data for the lake. The monitoring sites provide chemical and biological data that can be used for analytical analysis of changing water-quality conditions. Stresses to lake water quality are primarily caused by recreational use and activities that occur in contributing drainages to Lake Powell. Because of the high, recreational use (boating, camping, and day-use activities) on and adjacent to the lake, GLCA and the USGS have focused monitoring and research on selected organic and trace element contaminants. These compounds and elements have a direct link to fuel-powered watercraft such as personal watercraft and power boats.

Future monitoring needs at the 20 sites include determining the accumulation of chemical constituents of concern that absorb on sediments, accumulate in pore-waters of sediments and in the sediment-water interface zone, and also measuring compounds and elements that can bioaccumulate in fatty tissues and vital organs of aquatic biota. GLCA has recently initiated a program to prevent the introduction of the invasive Zebra (or quagga) mussels that have invaded some western water ways. Once these mussels establish themselves in water systems, they are nearly impossible to eradicate and can drastically affect the aquatic health of the water system. The mussels also can cause millions of dollars in damage to infrastructure. Marinas and other high use areas that are included in the network of sampling sites can be used to monitor this threat to ecosystem health.

The effects and presence of contaminants on water quality in Lake Powell have long been a management issue for GLCA as it relates to human and aquatic health. The network of 20 monitoring sites provides an opportunity for GLCA and the USGS to document changes in water quality for the long term and meet their management objectives of Lake Powell.

**DIGITAL HYDROGEOLOGIC MODELS OF BASIN-FILL AQUIFER SYSTEMS IN THE SOUTHWESTERN NEW MEXICO BORDER REGION—A POWERFUL TOOL FOR BINATIONAL WATER-RESOURCES MANAGEMENT**

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Since 1996, there has been a major multi-institutional, binational effort to characterize transboundary aquifer systems in the southwestern New Mexico, western Texas, and northern Chihuahua region of the USA and Mexico. This region includes a long segment of the Rio Grande Valley, adjacent intermontane basins of the Rio Grande rift tectonic province, and the El Paso (TX)/Ciudad Juárez (Chih)/Las Cruces (NM) metro-area with a population exceeding two million. Research at the New Mexico Water Resources Research Institute at New Mexico State University has emphasized development of digital hydrogeologic models and GIS databases that integrate large amounts of geologic, hydrologic and geochemical data on basin-fill aquifers in the transboundary region. This information has proven to be a powerful tool, not only in development of water-resource management strategies but also in the broad area of institutional and public education.

The GIS (map and cross-section) format allows 3-D integration of surface and subsurface information (to mean sea level) that can then be used in numerical groundwater-flow modeling and for hydrogeochemical interpretations. The hydrogeologic framework of intermontane-basin and mountain-block aquifer systems is defined in terms of 1) dominant lithofacies-assemblages (LFAs) that are grouped as informal hydrostratigraphic units (HSUs), and 2) mountain-block and intra-basin structural features that characterize this part of the American West. The major transboundary aquifer systems include the Mesilla and southern Jornada (del Muerto) Basins, and western Hueco Bolson of the Rio Grande rift tectonic province. Three surficial hydrogeologic maps (ArcGIS® format), two structure-contour maps, with basin-fill/bedrock contacts delineated (ArcGIS® format), and 33 schematic cross sections (Adobe Illustrator® format) have been completed to date. Base-map scale is 1:100,000 and the map area covered is about 20,000 km2 (~7,700 mi2).

Major aquifers are formed by coarser-grained LFAs deposited by the ancestral Rio Grande fluvial system. These poorly consolidated sediments are informal subdivisions of the middle and upper Santa Fe Groups, and overlying alluvial-basin and river-valley fills (late Miocene to Holocene). Aquifer horizontal hydraulic conductivities range from 3-30 m/day, and HSUs are
as much as 200m thick. Contiguous piedmont-slope LFAs and underlying middle and lower Santa Fe Group HSUs (middle and lower Miocene) usually have much less aquifer potential because of finer matrix texture, more consolidation and cementation, and lower water quality.

THE NATIONAL ASSOCIATION OF STATE BOARDS OF GEOLOGY (ASBOG®) AND GEOSCIENCE LICENSURE IN THE UNITED STATES

Wilson H. Herrod, Ph.D., Wyoming PG #786, 2008 ASBOG® President, Cody, WY 82414

The National Association of State Boards of Geology (ASBOG®) held its first formal annual meeting in November 1990. The groundwork for that meeting was laid with a series of five meetings beginning in March 1988, initially involving the boards from four southeastern states (South Carolina, North Carolina, Georgia, and Florida), which registered, certified, or licensed geologists. These states sought to discuss issues of reciprocity and common administrative problems and solutions. Eventually, the scope of these meetings expanded to include discussions of a national rather than a regional focus, including the need for a national licensure examination. Today, ASBOG® consists of 28 member states and Puerto Rico with at least three additional states actively working on legislation to establish licensure. Our state Member Boards have issued over 39,000 licenses, with some geoscientists holding multiple licenses in different states. The organization has evolved to the point where forums such as this meeting underscore the need to consider the possibilities for international cooperation and reciprocity in the practice of geology.

ASBOG® should perhaps be known as the National Association of Individual State Boards of Geology to emphasize its role as the link between independent geoscience registration and licensing boards. Geology today involves new, complex and challenging environmental, hydrogeological, and geo-engineering issues, as well as established demands for energy and minerals. However, the practice of geology exhibits a great deal of commonality among the member states, which allows ASBOG® to prepare and rigorously maintain national examinations covering both the practice of geology (PG Examination), and the fundamentals of geology (FG Examination). These examinations are used by all of our state Member Boards and will be discussed in detail in a subsequent presentation. Their over-arching purpose is to promote professional geological competence and ethical practice to insure that the health, safety, and welfare of the public are protected.

As ASBOG® has continued to evolve and grow, new challenges have appeared. Among these is the eventual need for specialty, or modular, examinations to complement a modified PG Examination once demand for such testing reaches critical mass. While some member states require a state-specific examination on local geology in addition to the FG and PG examinations, the modular PG examination would emphasize more detailed testing of certain skill sets such as petroleum, mining, or hydrogeology. An additional challenge is the need to maintain the financial solvency of ASBOG®. We are largely a volunteer organization and our financial security has never been in question. However, ASBOG® has grown, and we recognize the need for additional paid staff and consultants to maintain more complex examinations and to respond to greater administrative demands. Therefore, in 2008 we formed the ASBOG Foundation as a way for concerned individuals and companies to sponsor our efforts.

Finally, we have seen a softening of the undergraduate geology curriculum in some US colleges and universities to the point where the definition of a fundamental degree in geology has become blurred. Perhaps as an objective standard, the ASBOG® FG examination could be a benchmark for departmental performance as well as an exit examination for prospective graduates.

PROVIDING A NEXUS BETWEEN LAND USE AND WATER RESOURCES - DEVELOPING MUNICIPAL WATER POLICIES TO ENSURE LONG-TERM SUSTAINABILITY

Bradley M. Hill, R.G., Water Resources Manager, City of Flagstaff, AZ

In response to the complexity of water resource management and continued population growth in Arizona and other southwestern communities, water professionals and elected officials often discuss and debate alternatives ways to ensure growth and development is supported by a sustainable long-term water supply. For decades communities in Arizona have relied upon mined groundwater for their source of water supply. Some large central Arizona communities have invested significant sums of money into treatment and delivery infrastructure and surface water rights in an attempt to make their water supplies renewable while most rural communities in the state have not had that ability for a variety of reasons.

An additional water resource management tool communities might want to consider is the adoption of various water policies that may help them move towards a more sustainable water supply. While there has been some discussion in the Arizona water community on this topic, one such community, the City of Peoria located in the northwest portion of the Phoenix metropolitan area, was successful at formally adopting a set of water policies in November 2007 that were designed to preserve the public’s trust in the City’s water system through strategic long-term planning, compliance with state and federal regulations and the
demonstration of leadership in the stewardship of this limited natural resource. Additionally, this community went one step further by creating a nexus between land use and water supply by developing a Land Use Management policy within its Principles of Sound Water Management report. Specifically, this policy created a new evaluation criteria given the name, economic value per gallon of water, to help compare a proposed development’s land use, water needs and economic impact to the City in a measurable, quantitative way. This policy permits City staff, Planning & Zoning Commission and City Council to evaluate the revenues (direct and indirect economic benefits such as impact fees, sales and property taxes, etc), the expenses to provide municipal services (such as police, fire, library, water, sanitation, etc) versus the water use required for the existing land use and the proposed new land use.

In conclusion, many cities in the southwest are experiencing continued population growth and looking at various ways to ensure their growth is supported by a sustainable, long-term water supply. Some communities may want to discuss, debate and possibly adopt a set of water policies to get them closer to that goal. One such policy that some may want to consider is the linkage between changes in land use and the impacts of that change on a municipality's water supplies.

**USING CONTROLLED FLOODS TO RESTORE THE GRAND CANYON**

Michael Hoenig, School of Forestry, Northern Arizona University, Flagstaff, AZ

Aregai Tecle, Ph.D., School of Forestry, Northern Arizona University, Flagstaff, AZ

Regulation of the Colorado River at Glen Canyon Dam has resulted in significant changes of various types to the Colorado River in the Grand Canyon. There are changes in channel geomorphology, endangered species habitat, recreation opportunities, and the structure and composition of riparian plant and animal community resulting from the altered hydrologic regime of the Colorado River. The seriousness of these changes have called for conducting controlled flooding experiments to restore the riparian areas along the Colorado River downstream from Glen Canyon Dam. So far three high flow experiments with roughly 1,150 cubic meters per second of release were conducted in 1996, 2004 and 2008. Each time, an interdisciplinary group of scientists was organized to monitor and evaluate the effects of the experimental releases on the ecology and beaches along the Colorado River in the Grand Canyon. In each experiment, the amounts of water released from the dam represent a significant departure from normal dam operation flows. These experimental high flow releases create an unprecedented opportunity to examine the possible use of controlled floods as a restoration technique in many rivers around the world. The paper examines published materials on the use of controlled floods to restore degraded streams and for evaluating the type of management practice that may be employed in the Colorado River and elsewhere to restore rivers impacted by flow regulation.

**ARIZONA NEMO WET/DRY MAPPING OF THE AGUA FRIA RIVER**


Arizona NEMO has developed a mapping protocol and GIS data management and processing methodology to record the perennial reaches of Arizona Rivers. Built on a local community volunteer monitoring program that has gathered on the third Saturday of June since 1999 to record where water flows in the San Pedro River, NEMO Wet/Dry has formalized the volunteer monitoring program and expanded the activity across Arizona.

The main objective of the monitoring program is to create a map that shows where water is present, and where it is not, in the driest time of the year immediately prior to the Monsoon rains of summer. By mapping during the ‘dry’ season, information as to river base-flow and the interrelationship between surface water and ground water is clarified.

The goal of yearly monitoring is to create a long-term record of changes in that flow - while the record of any single year is interesting it is a record for multiple years that may tell what is really happening to the flow in the river. In addition, the goal of Wet/Dry is to build community participation, provide outreach education on the importance of long-term monitoring of our natural environment, and foster understanding of and responsibility for the health of Arizona watersheds.

Based on the successful efforts at the San Pedro Riparian National Conservation Area, Arizona NEMO, in cooperation with the Upper Agua Fria Watershed Partnership, the BLM, Friends of the Agua Fria National Monument, Arcosanti, and the Arizona Riparian Council, is presenting an opportunity for residents and property owners to learn more about flows in the Agua Fria River. On June 21, 2008, teams of scientists and volunteers will walk the river to map where the Agua Fria River flows and where it doesn’t. Using GPS technology, they will help develop a long term database to understand flows and trends on the river. This presentation will provide background on the project, and an overview of the monitoring techniques.
WATER, ELECTRIC POWER AND GROWTH IN SOUTHERN ARIZONA

Joseph Hoover, University of Arizona, Tucson, AZ, Christopher Scott, Assistant Professor, Udall Center for Studies in Public Policy, University of Arizona, Tucson, AZ

The water-energy nexus is the conglomeration of water and energy resource management, which results in complex policy challenges. Water is required for most forms of energy production and energy is required to utilize water resources. The relationship between water and energy is an intricate one and recognition of their interlinkage is vital for improving use of relatively scare resources in water and energy stressed regions. Unfortunately, water and energy resources are traditionally disjointedly managed and the synergistic relationship between the resources is over looked. In Arizona significant population growth in addition to aging infrastructure is stressing water and energy resources. The water use cycle is the five main stages of water consumption ranging from transportation, extraction, treatment, distribution, wastewater collection, treatment and water reuse. Preliminary results indicate that the energy for pumping and distribution in Tucson ranges between 750 and 920 kilowatt-hours per acre-foot and an average of 66 kilowatt-hours per acre-foot for water treatment. Water reuse is energy intensive as well using between 2,500 and 4,000 kilowatt-hours per acre-foot. In total, the energy cost of potable water in the Tucson Water system is at least 3,956 kilowatt-hours per acre-foot of water and reused water costs at least 6,397 kilowatt-hours per acre-foot. Tucson’s energy use for water service provision is expected to be relatively high compared with other water systems in the state that we will research. The opportunities for reducing energy consumption include conservation and decentralized reuse, and will need to be in regulatory compliance and driven by public choice.

BATHYMETRIC SURVEY AND STORAGE CAPACITY OF UPPER LAKE MARY NEAR FLAGSTAFF, ARIZONA

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Upper Lake Mary is a preferred drinking-water source for the City of Flagstaff, Arizona. Therefore, storage capacity and sedimentation issues in Upper Lake Mary are of interest to the City. The U.S. Geological Survey, in cooperation with the City of Flagstaff, collected bathymetric and land-survey data in Upper Lake Mary during late August through October 2006. Water-depth data were collected using a single-beam, high-definition fathometer. Position data were collected using real-time differential global position system receivers. Data were processed using commercial software and imported into geographic information system software to produce contour maps of lakebed elevations and for the computation of area and storage-capacity information.

At full pool (spillway elevation of 6,828.5 feet above mean sea level), Upper Lake Mary has a storage capacity of 16,300 acre-feet, a surface area of 939 acres, a mean depth of 17.4 feet, and a depth near the dam of 39 feet. It is 5.6 miles long and varies in width from 308 feet near the central, narrow portion of the lake to 2,630 feet in the upper portion. Comparisons between this survey and a previous survey conducted in the 1950s indicate no apparent decrease in reservoir area or storage capacity between the two surveys.

ASSESSING A DESTRUCTIVE ELEMENT OF SURFACE WATER/GROUND WATER INTERACTIONS - GROUND WATER FLOODING

Brent E. Huntsman, Terran Corporation, Beavercreek, OH, Kelly C. Smith, Daniel J. Wagel

Since the early 1900s, flood control on the Great Miami River (GMR) in southwestern Ohio has been achieved through the use of five dry dams and an extensive levee system. Many of the cities, smaller municipalities and industries protected by these structures obtain their water supplies exclusively from the buried valley of the GMR, a federally designated Sole Source Aquifer. From the early 1940s through the 1960s, widespread ground water withdrawal suppressed the local water table over 7.6 meters (25 feet) below average in Dayton, Ohio. Cessation of these pumping centers during the 1970s has allowed the water table to recover to pre-1940 levels, bringing ground water levels very near or above many building basements and subsurface utility vaults. During periods of high river stage, surface water recharge to the aquifer is focused upon the flood plain area between the levees in Dayton, causing significant ground water mounding. As this mounding propagates away from the river, many nearby subsurface structures are inundated from rising ground water; forcing more and more building owners to install and maintain dewatering systems for protection.

To delineate the ground water flooding potential within the City of Dayton, a MODFLOW model was developed. The model’s boundaries were chosen based on the best fit between key hydrogeologic features and the location of the area of greatest concern for basement flooding. The model domain of 7020 hectares (27 sq. mi.) was represented using 133 rows and 105 columns of variable widths and lengths. The Fixed Grid Approach was chosen to simulate the vertical layers, consisting of 30 layers of variable thickness.
Historical and recently developed aquifer information concerning lithology, hydraulic conductivity, recharge and streambed leakance were used as model inputs. For hydraulic conductivity, initial values for the outwash deposits ranged from 30 to 150 meters/day (100 to 500 feet/day) while values for glacial till or other silt/clay layers varied from 0.03 to 0.15 meters/day (0.1 to 0.5 feet/day). Recharge rates were modeled based on the predominant soil type present in the model cell. Areas dominated by steep topography, clayey soils developed over glacial till or intensive development were given lower recharge rates from 10 to 15 cm/yr (4 to 6 in/yr). Areas of flat topography and sandy soils developed over outwash were assigned higher recharge rates, 15 to 23 cm/yr (6 to 9 in/yr). Values for streambed hydraulic conductivity were estimated using historical measurements obtained within the GMR and its tributaries.

The model was calibrated to groundwater potentiometric surface elevations measured during a 1993 aquifer characterization study by the U.S. Geological Survey. The various model parameters were adjusted to obtain a best fit using regression techniques between the measured values and the calculated model heads. Once calibrated, this model was used to estimate ground water levels in the downtown area during 10, 50 and 100-year flood events. To better predict ground water levels at specific locations within the affected area of the city, an artificial neural network (ANN) model was created. Long-term ground water levels obtained at a well located in the basement of Dayton’s City Hall were assessed together with meteorological records from NOAA and river discharge measurements from the Miami Conservancy District using a backpropagation ANN algorithm. After considerable training using approximately a decade of data, the ANN model can accurately reproduce the ground water levels up to the 20-year flood event.

To investigate the long-term interrelationship of surface water and ground water near downtown Dayton, a thermometric study was completed. A total of eight access tubes were installed on the downstream side of bridge piers in the GMR. Each access tube was fitted with a string of single-channel temperature data loggers. Using vertical temperature profiles, seasonal temperature changes, and water level elevations measured at these access tubes, the hydraulic interconnectivity between the upper BVA aquifer and the river bed was determined. About one year of data was used to calculate seepage velocity rates and hydraulic conductivity values for the upper aquifer. The GMR can be both a losing and gaining stream with typical streambed leakance velocities ranging from -6 to +7 cm/day (± 0.2 feet/day).

This presentation will summarize the various data acquisition and modeling activities completed to define and assess the ground water flooding potential in the City of Dayton.

POSTAUDIT OF HEAD AND WATER BUDGET VALUES IN PREDICTIVE SCENARIOS OF THE CURRENT TRENDS ANALYSIS OF THE SALT RIVER VALLEY, ARIZONA, REGIONAL GROUNDWATER FLOW MODEL

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Just how accurate – and thus how useful to policy-makers – are a model’s predictions? This is one of the most relevant yet elusive issues for numerical simulations, including regional groundwater models. A study designed to help answer the question of predictive accuracy returns to a regional groundwater flow model at a later date and compares the head and water budget values forecast by the model with what actually came to pass, and is called a “postaudit.” In the case of Arizona’s Salt River Valley (SRV), the numerical model was created by the Arizona Department of Water Resources (ADWR) in 1992, yet no postaudit has ever been conducted to determine the accuracy of its predictions. The SRV Model is used as a predictive tool in the decision-making processes of the local and state government agencies responsible for public water resource management, and is also used as a framework for the groundwater modeling activities of private consultants that advise a diverse collection of private and public entities on water resource issues. Thus the validity of the SRV Model’s predictions is a matter of import to many parties, with postaudits the primary tool for such validation.

This investigation concentrates on the accuracy of the forecasts created in 1996 for the “Current Trends Alternative (CTA) Analysis using the SRV Model” (CTA Model), as compared to the hydrologic reality that emerged since the simulation was run in 1996. The CTA Model, the second iteration of the SRV MODFLOW Model, examined groundwater use and supply trends from 1989 – 2025, making it the only iteration for which sufficient time has elapsed since original date of simulation to allow a postaudit. The model’s predictions for the years 1996-2006 are compared to hydrologic parameters that were measured by ADWR, including heads and model water budgets. Thereafter follows a discussion of the factors that led to some of the identified divergences. These factors include the model’s conceptual design, resolution, hydrologic areal extent, data availability and integrity, boundary conditions, and underlying assumptions such as those regarding climate patterns and urbanization. Boundary conditions were an issue, as the model did not capture their changes over time; the Pinal boundary, modeled as constant, in reality changed over the simulation period from an influx to an outflux. Projected rainfall and surface-water volumes were based on historic patterns, and failed to account for extended drought. Pumping estimates were given directly by each entity’s water manager, in a void with no collaboration among the water managers, which lead to systemic underreporting of predicted water demands.
This postaudit’s results are instructive, in that they consistently point to the need for stronger collaborative efforts during a groundwater model’s design and construction. Potentially helpful cooperative opportunities range from the interdisciplinary coupling with up-to-date climate and urbanization models, to richer collaborations within the hydrology/water management community during data-gathering and scenario-building phases.

AN INTEGRATED SIMULTANEOUS APPROACH TO GROUNDWATER REMEDIATION USING ENVIRONMENTAL HAZARD EVALUATION AND REMEDIATION MANAGEMENT ZONE MAPS

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It is well documented that the time and cost of remediation expands exponentially once aggressive cleanup beyond the immediate source zone is required—often after a delay of several years. Environmental Hazard Evaluation (EHE) and Remediation Management Zones (RMZ) are used to address the common problems of sequential remediation, regardless of the contaminant. This remediation planning approach is applicable to all bodies of groundwater (and soil), whether or not the groundwater is a source of drinking water.

Primary contaminants of concern (COCs) are identified by comparison of initial groundwater data to comprehensive, Environmental Screening Levels (ESLs) or other regulatory goals. Investigation is considered complete when the area of contamination that exceeds the ESLs is adequately defined. A comparison of data to more detailed screening levels is then used to identify specific, potential environmental hazards associated with each COC (drinking water toxicity, vapor intrusion, impacts to aquatic habitats, gross contamination, etc.). Environmental hazard maps are then prepared to collectively delineate areas of groundwater where specific types of environmental hazards are posed. This information is summarized in a brief EHE report and passed on to the group tasked with development of remedial action plans.

The hazard maps are used to segregate the contaminated groundwater into three separate RMZs based on a prioritization of the hazards posed. RMZ boundaries are either ESLs applicable to the targeted hazards, technology limitations or alternative targets based on site-specific considerations. The zones take into account the nature of the specific hazard posed, threats to active water supply wells and nearby surface water bodies, threats to existing or future buildings that could be affected by vapor intrusion hazards, resources available for cleanup and other site-specific factors as applicable and appropriate. Zone 1, termed the Source Zone, is slated for focused, aggressive treatment of primary contaminant source areas as well as hazards that pose imminent threats to human health and the environment. Resources available for cleanup are focused on this area of groundwater. Zone 2, the Residual Zone, is slated for passive treatment or aggressive spot treatment to address intermediate priority hazards. Environmental hazards posed by contamination in this zone need to be addressed, but time constraints are less of a burden. In some cases, long-term management and monitoring of this zone may be the most appropriate treatment approach. Zone 3, or the Attenuation Zone, exists beyond the Residual Zone and does not exceed ESLs for any of the identified environmental hazards. Monitoring of this area (e.g., via groundwater data or soil gas data) is carried out as needed to ensure that contaminants do not continue to spread away from the Source and Residual Zones and to gauge the effectiveness of treatment initiated in the inner zones.

In sum, remedial strategies are concurrently developed and implemented for each RMZ simultaneously. Use of the EHE and the RMZ approach significantly improves the efficiency and effectiveness of groundwater investigation and cleanup actions.

INTERNATIONAL RECOGNITION AND CO-OPERATION, PROFESSIONAL QUALIFICATIONS AS PASSPORTS


Based as they are on a combination of academic qualification and relevant professional experience, professional qualifications are the international quality standards. They allow for mutual reciprocity and mutual recognition agreements between professional organisations. They further permit financial institutions and government bodies to demand that geologists must hold such a qualification in order to sign technical reports for submission to these bodies. The expansion of this international network of reciprocity is a major requirement for the development and mobility of the geological profession.
GEOTHERMAL ENERGY IN EUROPE
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The Geothermal resources of Europe range from the highest enthalpy fields of Iceland, Italy and Greece to the lowest enthalpy areas of Ireland and Norway. In all these countries geothermal energy can be, is being or will be exploited to provide heating, cooling and electricity for the local population.

All over Europe, shallow geothermal resources can be exploited by the same methods of Ground Source Heat Pumps in horizontal and vertical systems. Both open and closed systems are also used to access deeper geothermal resources, whilst in high enthalpy areas, high temperature fields, may be used directly for district heating or power production.

Geothermal energy is in line with the overall strategy of sustainable development in Europe. It is a sustainable energy source, remaining present throughout the years; it is available practically everywhere; and its use has a positive impact on the environment, since it results in significant reduction in CO2 emissions. It is receiving more and more attention from the European Commission and national governments, leading to a significant increase in activity on geothermal research and its exploitation as alternative energy source throughout Europe.

WATER MANAGEMENT SOLUTIONS FOR RURAL AREAS; A CASE STUDY OF THE UPPER SAN PEDRO PARTNERSHIP
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The Groundwater Management Act (GMA) of 1980 established the strictest regulation of groundwater pumping in Arizona history. These restrictions do not apply equally to all of the state, though. The GMA created strict management codes regulating groundwater pumping within Active Management Areas (AMAs). AMAs encompass eighty percent of Arizona’s population. However, only 13% of Arizona’s total land area is included in an AMA. The remaining 87% of land is subject to minimal groundwater regulation.

Non-AMAs are not regulated by the practices enacted within AMAs. These practices include a system of quantified groundwater rights, well regulations, and assured water supply requirements. Rural areas therefore lack many of the regulatory tools available to AMAs. As a result, rural areas are compromised in their ability to control groundwater pumping and effectively manage the effects of population growth.

In this paper, the Upper San Pedro Partnership (USPP) is used as a case study of strategies used by rural areas to solve local groundwater management issues. The partnership faces three primary water management challenges. First, the ecological health of the San Pedro River is declining. Second, Fort Huachuca could be closed due to its environmental impact on the river. Third, burgeoning population growth in Sierra Vista and Cochise County are increasing the demand for groundwater.

Congress formally recognized the partnership in 2003 and directed it to achieve sustainable yield for the regional aquifer by 2011. Progress towards this goal has been achieved, but it is evident that current efforts will not solve the groundwater overdraft problem. It is likely that water augmentation will be necessary to preserve river flows and reach sustainable yield. However, the USPP does not have the jurisdictional authority necessary to own or operate potential augmentation infrastructure.

To achieve the goal of sustainable yield, the USPP is currently pursuing the establishment of the Upper San Pedro Water District (USPWD). This paper explores the process of district formation and the potential results of USPWD approval by voters. The legislation authorizing the district and the authority to be granted to the USPWD are discussed. Limitations on authority and the timetable for approval are also presented. Augmentation options that are likely to be pursued are identified and explained. The challenges of obtaining voter approval of the district are then discussed. Finally, recommendations for future action are presented.

ATTITUDINAL AND ECONOMIC REALITIES IN A GLOBAL GEOSCIENCE WORKFORCE
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The geosciences, like all technical fields in the developed world, are facing a critical talent shortage. The retirement of the Baby-Boomers is now playing out and the long feared brain-drain is underway. At the same time, relative enrollments in technical
fields is declining, and absolute enrollments are, at best, remaining steady in the geosciences. The current supply is orders of magnitude insufficient to meet the rising demand for new geosciences workers, and when evaluated for quality, the pool is even smaller.

Several factors complicate the future of the geosciences in the United States. US student attitudes relative to the nature of career opportunities do not map well to the economic realities. Geosciences majors disfavor the primary pool of careers because of their attitudes towards the private sector and geographic mobility. Likewise, the resource industries of petroleum and mining are now competing with strong demand in groundwater careers, and by non-traditional industries seeking the analytic skill sets central to a geologic – spatial conceptualization and analysis.

This paper examines the data and trends currently being witnessed, and the various means by which geosciences employers are addressing the issues. Additionally, these trends and responses will be compared and contrasted to other areas around the world by examining the results of the AGI-sponsored workshop on global geosciences workforce at the 33rd International Geologic Congress in Oslo, Norway in August 2008.

UNCONVENTIONAL GAS RESOURCES – ARE WE PREPARED FOR THE JOURNEY OR HAVE WE ALREADY ARRIVED?

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The relatively mature state of global hydrocarbon exploration combined with increasing global energy demand and challenged accessibility to areas of significant conventional potential has caused industry to focus in additional arenas such as unconventional gas. While the recent flurry of announcements involving unconventional play types such as tight gas, shale gas, and coal bed methane may seem monumental to some, it is really only a reflection of the continuing evolution of the hydrocarbon extraction industry.

Unconventional gas plays are varied in nature and are found in diverse locations around the globe. Technology advancements in horizontal drilling, well stimulation and even liquefied natural gas processing and transport continues to expand the commercial landscape for these plays. Recent industry activities and advancements suggest that an even more technically diverse portfolio of gas opportunities may be on the horizon.

The rapid commercial extraction of gas from the unconventional resource play is one of the main objectives for industry. Accurate subsurface characterizations, matched to appropriate drilling and completion practices, are required to achieve this goal. Many of the opportunities involve formations with low porosity (less than 5%), low permeability (micro [10⁻⁶] to nano [10⁻⁹] darcy) and contain a variety of natural fracture styles. The origins of the gas found within these reservoirs can be thermogenic or biogenic and the gas may be completely adsorbed onto organic carbon, free within porosity and fractures or exist in some combination of these two states. Artificial stimulation of the pay intervals utilizing multi-frac techniques with innovative fluids in horizontal wells are commonly required to economically extract this gas. These opportunities can be found in regionally continuous accumulations and material production volumes may require drilling thousands of wells. Reducing the surface footprint of this activity as well as minimizing the draw upon local water resources are significant additional challenges currently being addressed.

While industry has begun the journey, it is clear that the work of many scientists will be required to identify and solve the novel issues associated with this growing portfolio of unconventional gas ventures in the coming decades. This will require creativity and innovation from many disciplines as well as significant interaction between industry and academia. Members of these integrated teams must be prepared to work in a highly technical and dynamic environment which will prove to be both challenging and rewarding.

THE ROLE OF ABSOLUTE GRAVIMETRY IN ARIZONA’S RURAL WATERSHED INITIATIVE PROJECTS

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The Rural Watershed Initiative, established by the State of Arizona, was formed to address water-supply issues in areas outside the State’s Active Management Areas, with an emphasis on regional watershed studies. In cooperation with the Arizona Department of Water Resources, the U.S. Geological Survey is conducting a number of hydrogeologic investigations under this initiative. This work has resulted in the expansion of networks of gravity stations for monitoring ground-water storage changes in rural areas of Cochise and Mojave Counties.

Temporal-gravity surveys are used to detect local changes in the gravitational field of the Earth. The method is readily applied to measurement of ground-water storage change in Arizona’s alluvial basins where significant variations in pore-space storage
occur. This results from ground-water mining and periodic (non-continuous) focused recharge. Aquifer-storage change is an important, but typically poorly known component of the ground-water budget in alluvial basins. In areas where water-table elevation data are available for unconfined aquifers, estimates of specific yield may also be obtained by dividing the volume of aquifer-storage change measured with the gravity method by the water-table elevation change in the unconfined aquifer.

Two instruments are used to monitor the gravity networks: the relative gravity meter and the absolute gravity meter. The relative meter is the primary instrument by which differences in gravity are monitored at stable monuments. Much as control benchmarks are used in conventional land surveying, repeated relative gravity surveys for ground-water storage monitoring should include a reference station where gravity is known to vary little, or where the absolute acceleration of gravity is monitored. The recent USGS acquisition of a Micro-g LaCoste A-10 field-portable absolute gravity meter allows monitoring of these reference stations as needed. This is particularly valuable in a hydrologic context where a number of absolute stations may be located throughout a basin, thereby serving to constrain a least-squares adjustment of the network of gravity differences obtained from relative gravity surveys.

In 2008, new gravity monitoring networks were established in the Willcox-Douglas and Middle San Pedro Basins in Cochise County, and in the Sacramento, Detrital, and Hualapai Basins in Mojave County. Biannual measurements will be made at the approximately 30 new absolute gravity stations established in these rural watersheds. Additionally, the simplicity of relative gravity surveys will allow for biannual gravity-change measurements at a greater number of locations within each basin than is possible with the absolute meter. Together these two techniques provide an efficient and valuable characterization of variations in ground-water storage in rural Arizona watersheds.

**EROSIONAL OR CONSTRUCTIONAL SHORELINES?**

**A GIS INVESTIGATION OF A PLAYA SYSTEM USING IFSAR**

**John F. Kennedy**, GIS Developer/Analyst, Caelum/Unitec, White Sands Missile Range, NM, 88002

This project deals with the apparent erosional features of a playa system in the Tularosa Basin of south-central New Mexico. The Lake Lucero playa is located near the western center of the basin and is located completely within the boundaries of the White Sands National Monument. Erosion along the margins of Lake Lucero has exposed ephemeral and perennial lacustrine sediments and geomorphic features predating the current playa. Many of these features can be seen on USGS 1:24,000 DOQQs and modeled using the 10m DEM available for the area. However, many of the subtle features seen in the field are not represented in the 10m DEM. IFSAR (Interferometric Synthetic Aperture Radar) data, available from Intermap (http://www.intermap.com), has a 5m horizontal resolution and a vertical accuracy of plus or minus 1m, which makes it possible to study subtle erosional and constructional features associated with the Lake Lucero playa. The IFSAR digital terrain model (DTM) and digital surface model (DSM) are derived from the Orthorectified Radar Image (ORI) datasets that has a pixel size of 1.25m. ArcGIS Desktop version 9.2, with 3-D Analyst and Spatial Analyst extensions, was used to model geomorphic features captured in the IFSAR data and map geologic contacts.

**GIS AND WATER RESOURCES – ARE WE EFFECTIVELY USING THE TOOLS AVAILABLE?**

**John F. Kennedy**, GIS Developer/Analyst, Caelum/Unitec, White Sands Missile Range, NM, 88002

The capabilities of GIS technology can provide us with many ways of studying water resources. The functions of GIS software commonly fall into two broad categories. Tools within a GIS software package provide the means to communicate ideas and concepts using paper/digital maps, charts, tables, or reports. However, most GIS software can do more than just create a pretty map. The analysis functions of GIS software can assist us in understanding our environment and make it possible for us to distill complex systems into something user-friendly, but are we effectively using the GIS tool to study water resources and convey that knowledge to the inhabitants of the arid southwest? An examination of web sites and on-line databases shows that, for the most part, these resources are designed more for the experienced GIS user and not for general public consumption. The solution to this dilemma is twofold. First, we need to marshal our resources and work with entities that develop water resource information and make these available to interested parties using KML clients (i.e. Google Earth). Second, we need to encourage local universities and GIS training centers to offer and promote database management and web mapping curricula to students in the Earth Sciences.

**CREATING AN ENVIRONMENTAL ENTERPRISE GIS DATABASE**

**John F. Kennedy**, GIS Developer/Analyst, Caelum/Unitec, White Sands Missile Range, NM, 88002

There are a number of questions to be answered when designing an Enterprise GIS database. Who will administer the GIS database, how will data be organized, who will be allowed to edit the GIS database, and how will the data be shared with other interested parties. A GIS database administrator, supervised by a GIS Manager, is responsible for establishing the databases...
within the relational database management system (RDBMS) and establishing the procedures for data loading and editing. Data should be organized based on type and frequency of modification. A useful guide is to place imagery in one database and vector data in another. In addition, sensitive data should be separated from data that is commonly available. A pyramid structure is recommended for staffing a GIS lab that runs an Enterprise GIS geodatabase. GIS editors work with the GIS database administrator to maintain the data. General GIS users, who use a GIS client like ArcView, are given access, but not allowed to modify the data. The non-GIS trained users can view maps, in a read-only environment, using a free GIS client (i.e. ArcReader) or using a web browser.

PRIVATE OWNERSHIP OF MUNICIPAL WATER SUPPLIES IN WESTERN U.S. MINING TOWNS
Bob Kent, Boise State University, Boise, ID

Private ownership of municipal water systems has and continues to be a subject of controversy. Critics question if private water companies can be entrusted with a resource that many consider a human right. However, prior to 1880, private investors owned over 50 percent of the domestic municipal water supplies in the United States. In 1920 the percentage of water systems owned by municipal governments was 68 percent and by 2007, public ownership had increased to 85 percent. Urban historians have advanced various theories to explain the rise in municipal ownership including: high water rates, inadequate volume or pressure for fire protection and provision of unsanitary water. One reason for municipal or public takeover of water systems in western mining towns was the collapse of the mining based economy and unprofitable operation of the water system. Only a tax payer owned system could operate at a loss. A notable exception to the municipalization trend was the water supply for Boise, Idaho. The water system, started by local entrepreneurs in 1890, remains privately owned, due in part to continued economic prosperity even when many nearby mines closed. By the early 1900s, Boise’s economy was diversified and dependant on agriculture versus mining. Many western mining towns were typified by boom and bust; the population rising quickly when gold or silver was discovered, and decreased when the gold ran out, silver prices dropped or bank failures dried up investment funds. Many mining towns were unincorporated and without taxing or bonding authority, private ownership was the only alternative for utilities or services typically considered municipal government responsibilities. In addition, city governments in western mining towns were dominated by entrepreneurs and business people who were opposed to taxes for municipal services which could be provided by private enterprise. For these western cities, municipal ownership was a last resort for maintaining a water system, implemented only when the private system failed or was in financial trouble.

AN OVERVIEW OF THE CASCABEL WATERSHED STUDY: PELONCILLO MOUNTAINS, NM
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Oak-savannas comprise over 80,000 square kilometers of the southwestern United States and northern Mexico. However, there is little hydrological data to aid with the management of these lands. The Cascabel Watershed Study is a modern day paired watershed study that was established in 2000. It is a collaborative effort between numerous entities to determine the effects of warm and cool season prescribed fire on a Southwestern oak savanna ecosystem. This study takes an “ecosystem approach” to watershed research in that it examines a suite of physical and biological components. Scientists from multiple organizations are collecting climatologic, hydrologic, geomorphologic, and biologic data to determine the full spectrum of ecosystem response to prescribed fire. This paper will provide an overview of the Cascabel Watershed Study and present some initial hydrological results following analysis of our pretreatment calibration data.

POTENTIAL EFFECTS OF PRESCRIBED FIRE ON WATERSHED PROCESSES IN SOUTHWESTERN OAK-SAVANNAS
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Oak-savannas comprise over 80,000 square kilometers in the mountains and high valleys of the southwestern United States and northern Mexico. However, there is relatively little scientific data to aid in the management of this broad ecotype. Fire, which was once the most important natural disturbance in this system, has been excluded due to over-grazing and fire suppression
practices. This has resulted in ecosystem changes and fuel accumulations. Prescribed fire is one management technique to restore natural processes within southwestern oak-savannas by reducing woody species density, increasing herbaceous plant production, and creating vegetative mosaics on the landscape. However, questions concerning the seasonality of burn treatments and the overall effects of these treatments on physical and ecological processes need to be addressed prior to broad management application. The Cascabel Watershed Study is a collaborative interdisciplinary study to determine the effects of cool-season and warm-season prescribed burning on a southwestern oak-savanna ecosystem. Twelve small watersheds in the Peloncillo Mountains of southwestern New Mexico have been monitored for seven years to provide adequate hydrologic calibration data prior to seasonal prescribed burning treatment application. These watersheds are grouped in four replicated blocks, each consisting of a cool-season treatment, a warm-season treatment and a control watershed. This paper will discuss the characteristics and behavior of the first round of cool-season and warm-season burn treatments, summarizing burn intensity and severity, and potential impacts on watershed processes.

**INVISIBLE DATA: DEALING WITH LESS THAN DETECTION LIMIT VALUES IN CONTAMINANT TREND ANALYSIS**

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Many of the available sources of water chemistry data contain a significant number of "less than detection limit" (<DL) or nondetectable (ND) values. The treatment of these datasets varies widely, resulting in varying interpretations of contaminant data depicted on isopleth (i.e., plume) maps and differences in analysis of spatial contaminant trends. In many cases, sampling points without detected contaminants are omitted from reports and databases entirely, in the interest of saving space or computer memory. These ND values are legitimate data, and should not be altered or omitted from datasets. The user of the data is responsible for choosing and thoroughly documenting a consistent treatment method for ND data.

An actual dataset containing over 400 data points was used to develop a series of isopleth maps to illustrate development and movement of a contaminant plume. Nine compounds were tracked from 2000 to 2007 as contaminants and/or markers. A standard procedure was developed for processing measurements taken at different frequencies and/or times into a single annual value for each measurement point. Values were gridded using Kriging in Golden Software's Surfer v 7.2 software. Using the 2000 tetrachloroethene (PCE) data and the 2004 PCE data, four pairs of isopleth maps were generated to illustrate the result of four different ND treatments. Data points were determined by compositing all available data for a particular sampling point during a calendar year. 47% of the 49 composite data points from 2000, and 35% of the 95 data points from 2004 contained at least one <DL value. The third pair of maps using Cohen's procedure, as outlined in the EPA's RCRA Ground-Water Monitoring Technical Enforcement Document (USEPA, 1988). Finally, in the fourth pair of maps, the <DL data were entirely removed from the datasets.

Differences between the first and second methods were slight, and the overall shape and location of the resulting contaminant plume was substantially identical. The third treatment, using Cohen's procedure, altered the shape of the plume's edges slightly but was not significantly different from the first two. Removing the <DL data entirely resulted in significant changes to the shape, size, and location of the plume.

All available data must be included in the analysis of spatial contaminant trends. The method used to treat <DL or ND data in this case is less significant than the fact that it is included and documented. Rigorous statistical treatment of the data, in this case, did not improve the final result significantly. Censored datasets, unless complete data is included as an appendix or made available to subsequent analysts, are unreliable at best, and may actually be misleading.

**GROUNDWATER EXPLOITATION FROM A FRACTURED BEDROCK AQUIFER WITH LIMITED STORAGE**

Vit Kuhnel, LFR Inc, Scottsdale, AZ, Chris Benjamin, Town of Star Valley Water Taskforce Committee Chairman, Star Valley, AZ

The fractured granite aquifer in the foothills of the Mogollon Rim is currently the sole source of drinking water in the Payson area. Two neighboring towns, Payson and Star Valley, have overlapping groundwater extraction networks, where pump size, rather than sustainability, determines extraction rates. Multiple disputes between the two towns regarding groundwater resource management have ignited over the past several years. Payson, the larger of the two towns, straddles two watersheds: the Tonto and the Verde. Recently, Payson began to extract and export groundwater from Star Valley’s sole watershed (Tonto) located outside of any groundwater active management area (AMA) under the State’s purview. The Payson wells are operated as large municipal wells with yields of 100 to 550 gpm, whereas most of Star Valley’s wells are privately operated domestic wells.
pumped at 10 to 35 gpm. While some safe yield studies suggest that sufficient regional recharge exists to offset groundwater withdrawals, the majority of pumping stresses are concentrated within a small portion of the watershed.

To assess the impact of Payson’s withdrawals, Star Valley instrumented fifteen of their wells with water level data logger recorders. More than two years of data have been collected and analyzed, enabling trend analyses of seasonal variation, recharge events and stressed aquifer conditions. The analyses indicate that the fractured aquifer system is highly inter-connected with drawdown responses rapidly propagating over hundreds of feet along fracture directions. Quantification of extractions and meteoric recharge indicates that despite its expanse, the storage capacity of the aquifer system is very low.

The implications of these findings for this shared aquifer are that short-term stresses, such as pulsed municipal extractions, as well long-term cycles, such as droughts, both result in substantial induced drawdown effects on the order of tens of feet. The smaller domestic wells of Star Valley are affected by these fluctuations more than the large Payson wells constructed to greater depths. Attached is a hydrograph from a private well in the central portion of Star Valley that shows responses to individual pump pulses from Tower well, a large (550 gpm) producer operated by town of Payson.

In the figure, the groundwater elevation reported in the Sky Run monitoring well is shown in blue and the daily extractions from the Tower well are plotted in red. Clearly distinguishable is the initial pump shake-down (April 2006), testing (February 2007) and initially modest extraction (through June 2007) in this well located 1,225 feet away from the Tower well. In July 2007, the Tower well’s production rate was upped by a factor of three, and then again in July 2008 by a factor 12 to approximately 182,000 gallons per day.

Very little water level recovery was recorded during the 2006-07 winter recharge season which brought 5 inches of precipitation (Nov-Mar). The 2007-08 winter season, on the other hand, was very wet at 14 inches of precipitation. The recharge effects are shown as a 15-foot mound in the hydrograph where individual storm events can be discerned as separate peaks. Of concern is how rapidly all the gain in storage from the last winter has been removed by Payson’s Tower well. Within five months after the last storm event, the water level in the monitoring well is at a historic low and the trend is steeper than ever before.

A sustainable production rate can be defined as volume in storage divided by number of years that the stored water is expected to last in a drought. The shown hydrograph indicates this last production rate to be sustainable for less than a year. Furthermore, any drops in water level, whether induced by drought or a neighboring production wells, adds to the lift costs of the private well owners. It is not surprising that private well owners are highly concerned about the growing impact caused by Payson’s well in the center of their community.

The continuation of the current system of overlapping zones of influence does not bode well for the domestic well operators. Escalating water demands in the area will only aggravate the issue, unless an organized extraction scheme is implemented with multiple and separated groundwater extraction centers. Mutually acceptable sustainable yields must be developed for such pumping centers and adhered to, to fairly serve both communities. To avoid these water conflicts from re-occurring, the State of Arizona needs to address rural areas outside of existing AMAs to account for recent growth and changes in land use and population density since the AMAs were established. In the presence of enforceable water laws (5-10 rule, in five years no more than 10 feet of induced drawdown; and no groundwater exports outside of the watershed), the private well owners would not have to struggle with an overbearing, thirsty neighbor in a climate where water is often the foundation to livelihood.

GEOLOGY-BASED UNITIZATION OF RESERVOIRS IN THE PETROLEUM FIELDS OF LOUISIANA: AN OVERVIEW

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Louisiana is a major oil and gas producing state in the U.S.A. The exploration for and production of oil and gas in this state are regulated by the Office of Conservation at the Louisiana Department of Natural Resources under the laws of the state. The unitization of a petroleum reservoir which involves the equities of the mineral right owners is a process of integrating separately owned tracks of land, mineral leases, and other property interests overlying the reservoir for joint development or production of the reservoir. An oil or gas well is allowed to be drilled, completed in and produced from a reservoir on a single lease or a voluntary unit or a compulsory unit. A compulsory unit, also referred to as conservation unit is established by the Office of Conservation. It may be a single well unit or a reservoirwide (multi well) unit. A single well unit is the maximum area representing a portion or entirety of a reservoir that can be drained efficiently and economically by one well. A reservoirwide unit encompasses the entire reservoir, such unit being formed with the approval of the majority of working mineral interest owners and mineral owners. Among other factors, geology plays a paramount role in the establishment of such drilling and production units. This is the focus of this presentation.
In South Louisiana, the units established for exploration for and production of oil and gas are generally characterized by geological boundaries. They reflect varied geological settings with stratigraphic, structural or combination traps. They are generally situated on a salt dome, a domal structure, an anticline, a roll-over associated with a growth fault or in separate fault blocks. The geological boundaries of the (geological) units may be defined by fault lines with or without a gas/water contact, an oil/water contact, a sand pinch-out or a shale-out or a permeability barrier or a combination thereof. The unitized reservoirs in South Louisiana exist mostly in the Miocene, Oligocene (Frio), Eocene and Paleocene Formations (Claiborne and Wilcox Groups) and the Upper Cretaceous Austin and Tuscaloosa Formation. The units with geographical boundaries (based on non-geological factors) are historically less common in South Louisiana than in North Louisiana. The existing unitized reservoirs in North Louisiana are located in the Upper Cretaceous, Lower Cretaceous and Upper Jurassic rocks. The Upper Cretaceous reservoirs exist in the Tuscaloosa Formation as well as the Austin, Taylor and Navarro Groups. The Lower Cretaceous reservoirs are generally part of the Paluxy Formation, Rodessa Formation, James Limestone, Sligo Formation and Hosston Formation. The Upper Jurassic reservoirs occur in the Smackover, the Haynesville, and the Cotton Valley Formation. These reservoir rocks exist as lenticular and discontinuous bodies with low porosity and permeability and unpredictable lateral variations in reservoir characteristics. During the early development of the petroleum fields in North Louisiana, in view of sparse well controls and limited thickness and irregular lateral extent of the reservoirs, drilling and production units were created with geographic boundaries coinciding with government township-section lines or sometimes property lines and such historic trends still continue in North Louisiana. Examples illustrative of statewide variations in the patterns and configurations of conservation units are highlighted in this presentation.

"REFERENCE" WETLANDS REFERS TO … WHAT?

W. Bruce Lafrenz, PG, Tetra Tech, Orlando, FL Joseph F. van Gaalen, Tetra Tech, Orlando, FL

Public water supply development and production from groundwater sources is increasingly constrained by the potential for adverse impacts to wetlands. As a method of gauging those impacts, some water regulation agencies in Florida are attempting to compare water level responses in potentially affected wetlands to “reference” wetlands. In this method the reference wetland is meant to act as a scientific control. The intent of the method is to examine several potential responses to drawdown in control wetlands and on the wellfield site. Statistics proposed for comparison include magnitude of water table decline, increases in the rate of water table decline, and decreases in the period of inundation of the wetland. Although well-meant, the method is unreliable. Any detected changes cannot, except in extreme cases, be uniquely attributed to wellfield operation because the fundamental assumption of equivalence of all factors cannot be ensured. In using a scientific control it is assumed that all variables that influence the response to a test are equivalent at both the control and subject sites. In reality, many factors influence the magnitude of water table elevation changes, the rate of change, the timing of change, and other responses. Moreover, it is not sufficient to show that predevelopment responses are similar because the tested condition, drawdown, is not present in the predevelopment data. Thus, the stress being tested is not shown to have an equivalent effect, and the conclusion that differing responses indicate drawdown impacts is not proved. We describe a list of variables that can affect changes in water table elevation, the potential influence of each, and the difficulty of ensuring equivalence between the reference wetland and the wellfield sites. We examine a case study in the Southwest Florida Water Management District - the City of Lakeland Northeast Wellfield and its proposed reference wetlands in the Green Swamp.

PERCHED GROUNDWATER IN CENTRAL FLAGSTAFF: IMPLICATIONS FOR IDENTIFICATION OF SOURCES AND EXTENT OF CONTAMINATION

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Perched groundwater in central Flagstaff presents some unique challenges to the identification and delineation of contaminant source areas and groundwater plumes. Typically, delineation of the extent of contaminant plumes can be accomplished once the following items are known: (1) location and size of source, and (2) groundwater gradient/flow direction. However, in this particular area of Flagstaff, perched groundwater is shallow, the groundwater gradient is fairly flat, and the presence and flow direction of groundwater is subject to seasonal fluctuations due to summer storms and winter snow melt. In addition, recharge is influenced by flows in the Rio de Flag, there are several domestic wells in the area, and multiple underground storage tanks for petroleum hydrocarbons and fuel. When leaks and spills from the tanks occur under the right conditions, there is the potential for creation of symmetrical plume migration. This complicates the job of evaluating potential migration of contaminants beneath adjacent properties and makes performance of due diligence for property transactions more difficult than it would otherwise be. This paper discusses the various factors to be considered during the performance of this type of work in the central Flagstaff and describes some techniques used to evaluate mobility of contaminants when the number and magnitude of variables is in flux.
A concern about rainwater harvesting that often sees little attention is the impact of water harvesting on surface water appropriators. All states in the southwestern United States allocate surface water according to the prior appropriation doctrine, which gives priority in water use to the earliest water user. Because rainwater harvesting is a recent innovation and because it captures water before it can runoff and reach prior appropriators, it is possible that water harvesting may interfere with existing surface water rights.

One of the overriding questions when considering water use within the structure of prior appropriation water rights is what water is appropriate. Each western state has different statutory language governing water rights. Depending on the wording of these statutes and the way they have been interpreted by the courts and policymakers, certain waters may be considered appropriable or unappropriable. This is especially the case with storm water runoff. Some western states and courts have found that storm water is appropriable, thereby restricting the ability of citizens to undertake certain types of water harvesting. Other states have determined the opposite, somewhere in between, or have yet to establish a clear precedent.

This paper reviews basic water harvesting techniques, briefly presents how water harvesting is being implemented in Arizona through the example of the City of Tucson, considers the approaches of three southwestern states with established rainwater harvesting policies – New Mexico, Texas, and Colorado, and considers how these approaches may provide guidance to Arizona for developing its own rainwater harvesting policy. New Mexico has taken a passive approach, allowing water harvesting, but also reserving the right to take further action if harm to appropriators is demonstrated. Texas has aggressively pursued rainwater harvesting programs, making clear policy statements in favor of rainwater harvesting despite very restrictive statutory language. Colorado has relatively unrestrictive statutory language but de facto has the most restrictive water rights system relative to water harvesting as a result of administrative level policy decisions and support for those decisions by the courts. Any of these outcomes are possible in Arizona because it lacks a statewide policy toward water harvesting.

**LEGAL IMPLICATIONS OF RAINWATER HARVESTING FOR EXISTING SURFACE WATER RIGHT HOLDERS: DOES ARIZONA HAVE A PROBLEM?**

**Aaron M. Lien, CAP Award Winner, University of Arizona, Tucson, AZ**

Sedona, Arizona, at an elevation of ~4400 feet (~1340 m), lies beneath the Mogollon Rim erosional escarpment along the southwestern margin of the Colorado Plateau. Bedrock at town level is Permian Hermit formation, a shaly sandstone and that is underlain by the competent Esplanade member of Supai Sandstone. Beneath that is Mississippian Redwall Limestone and Devonian Martin Dolomite. Permian Schnebly Hill Sandstone, Coconino Sandstone, Toroweap formation and Kaibab Limestone are exposed in the cliffs above town. With minor facies changes this stratigraphy is similar to strata exposed in the walls of the Grand Canyon a hundred miles (160 km) to the north-northwest. Surface runoff flowing through Sedona is independent of subsurface groundwater flow. Groundwater recharge of this portion of the Verde River basin begins on the Colorado Plateau at elevations of 6-8,000 feet (1,830-2440 m) over an area of perhaps 700 mi² (1800 km²) and possibly reaches up to the flank of the San Francisco volcanic peaks. The northern portion of the recharge area is undoubtedly shared with water wells situated to the west of Flagstaff. Subsurface groundwater flows southward toward Sedona beneath the Mogollon Rim and then southwestward toward the Verde River to an elevation of ~3300 feet (~1000 m) along the axis of the Late Miocene Verde graben. Oak Creek and its West Fork are the only perennial streams in the sub-basin and are fed by springs in canyons that cut into the Mogollon Rim escarpment. Ephemeral Dry Creek and Mortgage Draw drainages lie to the northwest and east of town. Studies by the USGS of its West Fork are the only perennial streams in the sub-basin and are fed by springs in canyons that cut into the Mogollon Rim escarpment. Ephemeral Dry Creek and Mortgage Draw drainages lie to the northwest and east of town. Studies by the USGS of oxygen isotopes contained in water from Sedona wells indicates that most of the groundwater originated at plateau elevations above 6900 feet (2100 m) and came mainly from winter snow melt. Sedona water wells tap the Mississippian age Redwall Limestone aquifer at depths of 450-600 feet (140-180 m) below ground level as well as from fractured Esplanade Sandstone. Grand Canyon outcrops reveal that the uppermost part of the Redwall Limestone contains a Mississippian age karst surface whose porous fractures have been reactivated by modern solution cave formation. Numerous artesian springs discharge into Grand Canyon from such Redwall Limestone cave openings. A similar Mississippian age inheritance of karst solution cavities is believed to have been reactivated in the Redwall Limestone that underlies Sedona. Water wells reveal abundant water-filled solution cave openings in the subsurface Redwall Limestone that lies below insoluble sandstone strata. Seven known sinkholes occur within an area of 8 by 11 miles (13 by 18 km) on the outer perimeter of Sedona. All sinkholes display active collapse features in relatively modern time. Devils Kitchen is the largest sinkhole, reportedly breaking through to ground level in the 1880s. A major collapse also occurred in late 1989 when a surface opening of 90 by 155 feet (27 by 47 m) had developed. Devils Dining Room sinkhole to the southeast exposes a 12.0 Ma basalt dike that follows a northwest fracture, indicating that a large cave at depth had formed after the dike had been intruded. Sinkholes have formed by collapse of large subsurface Redwall Limestone solution caves that have become too large to support overlying sandstone strata. Most sinkholes are associated with regional northwest-trending bedrock joints that occur throughout the Sedona area. Sinkholes appear to overlie an interconnected network of subsurface solution caves that formed along a dominant northwest-southeast and subordinate north-northeast trending...
joint set in local rock strata. A constant flow of groundwater passes beneath the greater Sedona area and eventually coalesces to emerge as artesian flow at Page Springs, located 9 miles (14.5 km) southwest of Sedona. This steady outflow of approximately 15 million gallons per day enters the southward flowing Oak Creek and Verde River drainages.

CHARACTERIZATION OF THE HIGHWAY 95 FAULT IN LOWER FORTY-MILE WASH USING ELECTRICAL AND ELECTROMAGNETIC METHODS, NYE COUNTY, NEVADA

Jamie P Macy, USGS Arizona Water Science Center, Flagstaff, AZ

The Highway 95 fault is a buried East-West trending growth fault at the southern extent of Yucca Mountain/Southwestern Nevada Volcanic Field. Little is known about the role of this fault in the movement of ground-water from the Yucca Mountain area to downgradient ground-water users in Amargosa Valley. The United States Geological Survey Arizona Water Science Center is using direct current resistivity, controlled-source audio magnetotelluric (CSAMT), and transient electromagnetics (TEM) to better understand the fault. These geophysical surveys were designed to look at structures buried beneath the alluvium, and follow a transect of wells for lithologic control. Initial results indicate that the fault is located approximately 600 meters north of U.S. Highway 95. The Highway 95 fault may inhibit ground-water movement by uplifting deep Paleozoic carbonates that reduce the overlying alluvial aquifer thickness and restrict the movement of water.

WELL SITING OPTIMIZATION SYSTEM

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The City of Kingman, Arizona is on a rapid growth curve resulting in an ever increasing demand for high quality drinking water, namely groundwater. A historical hydrogeologic basin analysis (Clear Creek Associates, 2003) included the development and utilization of a well siting spatial decision matrix which helped the city identify the most promising locations for future high capacity wells. Based on this study a three-well drilling program resulted in water flows that matched projections (Golder Associates Inc., 2007). In this fast-growing, water-constrained part of the world, being able to ensure an adequate volume of good-quality water is critical to any community’s sustainability.

The next generation of spatial decision support systems including this updated well siting optimization system (WSOS) can provide support for a city’s planning over the near-term and long-term. This type of planning tool can flex with the changing and evolving input datasets as the city evolves. For example, if a contaminant of concern is found to be encroaching on the study area, the WSOS decreases the suitability rankings in the proximity of the contaminant front. By storing the selection criteria in the WSOS, interested parties can also efficiently conduct what-if (scenario) analysis by changing the selection criteria to modify the well siting model. Kingman is one of the few places in Arizona where hexavalent Chromium (Cr+6) occurs naturally. The WSOS will allow users to evaluate future well suitability if Cr+6 becomes a regulated constituent.

The original study for Kingman included development of a Microsoft Excel-based prioritization matrix spreadsheet, which mapped approximately 260 square kilometers (100 square miles) into cells, indicating the desirability of each cell based on several static input datasets. The conceptual components of the original matrix were recently incorporated into the ArcGIS-based WSOS. Categorization, evaluation, and combination of individual selection factors can be easily computed by matrix analysis using ArcGIS Spatial Analyst and Model Builder software to automate the well siting analysis. Depending on the resolution of the available input datasets, advanced analysis techniques can be incorporated into the WSOS. This presentation focuses on the development, extendibility, and adaptability of the WSOS.

CERTIFIED GROUND WATER PROFESSIONALS AND THE DATA QUALITY ACT

Robert W. Masters, Hydrologist, Conference Manager, National Ground Water Association, Westerville, OH

The Certified Ground Water Professional (CGWP) designation was started in 1986 by the Association of Ground Water Scientists and Engineers Division of the National Ground Water Association. It is designed to uphold the dignity of their profession. Those who are granted certification are then asked to abide by seven cannons of professional practice. They shall:

- Perform services only in the areas of their competence
- Use their knowledge and skill for the enhancement of human welfare
- Serve the public, their employers, and their clients honestly, objectively, and impartially
- Avoid conflict of interest
- Act as faithful agents or trustees in professional matters for each employer or client
- Strive to uphold and enhance the honor, integrity, dignity, competence, and prestige of the ground water profession

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- Maintain their competence current through continuing professional development.

This presentation will give examples of projects conducted by Certified Ground Water Professionals practicing in the United States and discuss the certification process. The presentation will also cover the Data Quality Act of 2000 which mandated that the Office of Management and Budget issue guidance to Federal Agencies for "ensuring and maximizing the quality, objectivity, utility, and integrity of information (including statistical information) disseminated by federal agencies." Implications of the Data Quality Act for ground water investigations and environmental enforcement shall be explained.

PROFESSIONAL GEOLOGIST IN THE PROTECTION OF THE PUBLIC LICENSURE – ETHICS – SOCIETY
Christopher C. Mathewson, Ph.D., Texas A&M University, Department of Geology & Geophysics, College Station, TX 77843-3115

The driving force behind the licensure and registration of geologists is the fact that Geologists, especially Environmental and Engineering Geologists, are professionals who have a primary obligation to protect the health, safety and well-being of the public. Today’s Professional Geologist is no longer offered the opportunity to follow the “minimum required in the code” when doing so may lead to a loss to the public. In many areas, even today, geologists must work under the supervision of a Professional Engineer because their region does not recognize that the improper practice of geology can result in human losses and even deaths. The licensure and registration of Professional Geologists has elevated the profession to that of the Professional Engineer in which the legislature has recognized that “Bad Geology Can Kill People”. Licensure and registration not only increases the demand for professional skills but, more importantly, it demands Professional Ethics. All Professional Geologists now have a responsibility to the profession and to the protection of the public by exercising the police power that comes with professional licensure. Only through true ethical practice can a profession gain the reputation of being an Ethical Profession. The Engineering Profession has maintained a standard of practice and level of ethical awareness before the public that has generated a public trust in the Engineer. Geologists must follow this trail. Lastly, Geologists must recognize that their active participation in professional geological societies, both academic and practice, is how the Standard of the Practice is defined, improved and enhanced – technology changes, discoveries are made, new tools are invented – thus, the Standard of the Practice must also change and keep up.

NORTHERN ANNULAR MODE IMPACT ON SPRING CLIMATE IN THE WESTERN UNITED STATES
Stephanie McAfee, CAP Award Winner, Dept. of Geosciences, University of Arizona, Tucson, AZ
Joellen Russell, Dept. of Geosciences, University of Arizona, Tucson, AZ

Shifts in the position of the stormtrack that seem to be driven by anthropogenic activity are associated with reduced precipitation and warmer temperatures during the spring. The Northern Annular Mode index (NAM) provides a reasonable proxy for the position of the stormtrack. By correlating the mid-winter values of the NAM with relatively high-resolution temperature and precipitation data for the late-twentieth century, we have demonstrated that a poleward shift in the winter stortrack (indicated by positive NAM index values) is associated with reduced precipitation and warmer temperatures during the months of February to April. Given projected increases in the average annular mode index and associated poleward shifts in the stormtrack, this analysis provides additional evidence that much of the western United States, and the Southwest in particular, will experience more severe drought conditions over the next several decades, irrespective of changes in temperature, because of an earlier shift to warm-season circulation patterns. This may lead to an increase in the length of the hot, dry foresummer and to increased concerns about wildfire, sustainability of water resources, and energy requirements for a longer cooling season.

THE USE OF STORM-WATER MONITORING FOR THE EVALUATION OF SURFACE-WATER QUALITY OF LOWER NORTH POTATO CREEK, COPPER BASIN MINING DISTRICT, TENNESSEE

The Copper Basin Mining District is located in the southeast corner of Tennessee, near the boundaries with Georgia and North Carolina. The Copper Basin is the site of a massive sulfide deposit that was discovered in the 1850s. By the 1900s mining and mineral processing activities had left the basin denuded of vegetation and the streams filled with sediment. Currently, the basin has been revegetated and extensive reclamation activities are being conducted to restore the water quality in the Lower North
Potato Creek watershed. The remedial goals for the watershed are not based on numerical water quality criteria, but rather reestablishment of biological integrity as represented by the benthic macroinvertebrate community.

Due to the lack of macroinvertebrates in most stream reaches, surface-water monitoring (dissolved metals, wet chemistry and field measures) is being used to gauge success during the early stages of restoration. Both base- and storm-flow monitoring are being performed. Base-flow monitoring has documented improvements in the water quality in North Potato Creek from 2002 to the present, with concentrations in many reaches of North Potato Creek below the chronic toxicity criteria. Base-flow results could, however, lead to the erroneous conclusion that the remedial actions to date have been adequate to restore biological integrity. Storm-water monitoring has uncovered flow-dependent phenomena that may have a significant bearing on goal attainment. ‘First-flush’ events are linked to source areas where high concentrations of metals enter the streams during precipitation events. The high concentrations of metals occur prior to a measurable increase in stream flow or during the initial portion of the rising limb of the storm hydrograph. The former is apparently associated with rapid dissolution and runoff of surface salt deposits, while the latter may be caused by leaching of salts from materials near the creek. The ‘first-flush’ events produce short duration peaks of high metal concentrations often dramatically exceeding both chronic and acute toxicity levels.

The storm-water monitoring provides a more complete understanding of the factors controlling water quality within the watershed. In turn, this information will support remedial decisions aimed at elimination of acute toxic stressors that may otherwise go unnoticed preventing recovery of the macroinvertebrate community.

THE GEOLOGIST AND COGNITIVE DIVERSITY AS A KEY TO PROBLEM SOLVING
Shane D. McDonald, Malcolm Pirnie, Inc., King of Prussia, PA

Geologists are called upon to participate in problem solving teams as a matter of course. More and more these problems are complicated by cultural influences and technical advancements. As the problems we deal with become more complicated, the breadth of the team is necessarily widened. Understanding the processes of problem solving is critical for efficient problem solving team management. For this reason, it behooves the savvy geologist to understand how the human mind solves problems.

“Cognitive diversity” is the set of differences in the way each of us problem solve. These differences include our level (our intelligence, our skills, and our experience), our motivation (why we choose to solve this problem), and our style (in what way we solve problems). Of these factors, style is the least generally understood. A highly regarded theory put forth by Dr. M.J. Kirton describes cognitive style as the amount of structure preferred by an individual when they problem solve. People who prefer more structure are more adaptive, while people who prefer less structure are more innovative. Everyone lies on a continuum that ranges from highly adaptive to highly innovative. The distribution on the style continuum for large, general populations is a normal curve. Studies have shown that style preferences are stable in individuals by their early teens and remain so throughout life.

When a single individual solves a problem, cognitive diversity is only an issue in that person’s ability to meet the demands of the problem. As soon as a second person is engaged to assist in solving the problem, the diversity between the individuals will create a second problem: how to deal with each other. Even people with relatively small cognitive gaps in preferred style will feel a difference in how the other operates. If there is a large gap in style, there is a tangible difference that can cause discord. Because of lack of understanding, these differences are often rationalized as differences in level (e.g. you don’t do it like me because you can’t do it like me). It is important to recognize that problems, like people, occur along the length of the A-I continuum; therefore, all cognitive styles are necessary (in general) and no style is fundamentally superior to any other.

As a geologist managing a diverse team of individuals, with a range of expertise as well as a range of style, embracing diversity is the most effective way to assure an efficient team. Embracing the diversity can only be accomplished by first recognizing its existence. This talk will cover the basic premises of A-I theory and will introduce methods to help recognize and deal with issues that are the outcome of cognitive diversity.

DESALINATION OF BRACKISH GROUNDWATER IN ARIZONA

Recognizing that desalination of brackish groundwater will be an integral part of Arizona’s future water supply, the Central Arizona Water Conservation District has embarked on a program to identify and prioritize Arizona basins where desalination is most feasible. Brackish groundwater is defined for this study as containing 1,000 to 10,000 milligrams per liter (mg/l) total dissolved solids (TDS). Based on this definition, more than 600,000,000 acre-feet of brackish groundwater is estimated to be stored in Arizona aquifers, generally at depths of less than 1,200 feet. While this volume seems large, it is still modest in
Brackish groundwater is found throughout Arizona in a variety of hydrogeologic environments (Daniel 1981). Evaporite deposits are responsible for most salinity in northern Arizona aquifers, and agricultural irrigation is primarily responsible for brackish groundwater in southern Arizona. Evaporites are also a factor in southern Arizona basins, such as Safford, Picacho, and the West Salt River. Although dozens of brackish groundwater areas exist in Arizona, results of Phase I investigations indicate that only five or six have sufficient volume in storage to be of near-term interest for development of desalination projects.

The area extending from the Picacho basin near Eloy and continuing along the Gila River into the Yuma area is of interest because desalination could replace current or future Central Arizona Project (CAP) uses, augment CAP deliveries to the Tucson area, and/or possibly mitigate waterlogging in the Buckeye and Yuma areas. The Safford basin has a good potential for desalination, if large fresh-water supplies are needed in the area. The Willcox basin also may have a large volume of brackish groundwater in storage that could be treated and used to augment supplies near Sierra Vista. Finally, extensive brackish groundwater resources exist in the Little Colorado River basin, both on and off of the Navajo and Hopi Reservations. In the western part of this brackish groundwater area, near Winslow, desalination could be used to augment supplies for Flagstaff, provide drinking water for several Native American communities, and/or provide water for industrial uses. Several electrical generating stations are located in or near the central and eastern parts of the Little Colorado brackish groundwater area, suggesting the potential for future co-location of power and desalination plants in this area. Advantages of the Little Colorado brackish area include the fact that brackish groundwater withdrawals would not be anticipated to adversely affect adjacent fresh water areas, and that sodium chloride-type groundwater that occurs in the area is reported to be most efficient for desalination.

While there are several key prospects in the state, major limitations to groundwater desalination remain, including energy costs associated with treatment and the difficulty with brine disposal, especially in Arizona. Current costs to produce fresh water from brackish water range from about $2 to $5 per 1,000 gallons. Studies in Texas indicate that water in the 1,000 to 3,000 mg/l TDS concentration range is optimal for energy efficient treatment, with energy costs rising rapidly when TDS is above 15,000 mg/l. This is important because electrical energy accounts for about 45 percent of fresh water production costs. Although greater efficiencies are being achieved in desalination technology over time, gains may be offset by rising energy costs.

A major impediment to desalination in Arizona is the state’s classification of all aquifers as “Drinking Water Aquifers”, including those where salinity substantially exceeds that of seawater, or where yield rates to wells are less than one gallon per minute. Because brine injection into deep, saline aquifers is often the best, or only, feasible method of brine disposal, the ability to utilize Arizona’s abundant brackish groundwater resources may depend on a reappraisal of the aquifer classification system in the state.

IN-SITU RECOVERY OF SANDSTONE URANIUM DEPOSITS IN NEW MEXICO: PAST, PRESENT, AND FUTURE ISSUES AND POTENTIAL

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Several in-situ recovery (ISR) operations have been proposed to recover uranium from sandstone-uranium deposits in New Mexico, especially in the Grants district. In-situ recovery (also known as in-situ leaching, solution mining, solution-leach mining, leach mining) consists of injecting a solution into the mineralized zone through injection wells. The leach solution migrates through the formation, dissolves uranium and is recovered through production wells. The uranium is then precipitated through a conventional uranium recovery system at the surface.

Several criteria must be met in order for ISR to be successful. The ore zone should be in a nearly horizontal or slightly dipping sandstone unit that is confined above and below by impermeable units. The ore body must be in a saturated zone below the water table during the entire process. There must be sufficient permeability during the entire process to enable leach fluids to migrate and be recovered. The ore body must be amenable to chemical leaching.

A number of ISR operations or pilot tests have been conducted in New Mexico in the past with varying results (Mobil at Crownpoint, UNC-Teton at Section 23, Grace Nuclear at Hook’s Ranch, Section 13 north of Seboyeta and Church Rock, and Anaconda at Windwhip, part of the Jackpile Paguate mine). Kerr-McGee (later Quivira Mining Co., Rio Algom) and other companies successfully produced uranium from mine-water recovery (recirculated mine water or stope leaching) from their Ambrosia Lake underground mines from 1963 through 2002.

From these historical and other ISR operations throughout the world, some issues have been identified with ISR that can be solved with proper planning during the permitting process. One of the significant issues is that we characterize very well the mineralogical, chemical, hydrological, and physical parameters of the aquifer before ISR, but we do not always characterize these parameters as well during or even after ISR is completed. ISR mobilizes not only the uranium, but other minerals, which could
SUCCESSFUL REMEDIATION OF BENZENE AND TRICHLOROETHYLENE IN GROUNDWATER THROUGH STIMULATION OF IN-SITU BACTERIAL DEGRADATION

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Groundwater at two sites was successfully remediated using in-situ methods utilizing the injection of compounds designed to stimulate naturally-occurring bacterial degradation of targeted compounds. Benzene was the targeted compound at Site 1 and trichloroethylene (TCE) and 1,2-dichloroethylene (DCE) were the targeted compounds at Site 2. The results of the remedial actions indicate that the concentration of target chemicals (benzene at Site 1, and TCE and DCE at Site 2) were decreased to acceptable risk levels for occupants within future buildings built on grade at each site.

Injection of an aerobic biodegradation substrate [specifically Oxygen Releasing Compound (ORC)-Advanced®] was utilized to enhance in-situ bacterial degradation of benzene dissolved in groundwater beneath Site 1. Prior to injection, benzene was detected at 1000 µg/l in groundwater beneath Site 1. Approximately 2,050 pounds of ORC-Advanced® was injected into the subsurface at a total of 52 injection points at Site 1. Groundwater was sampled prior to injection to create a baseline set of data and again at 1 month, 3 months, 5 months, and 12 months after injection. The groundwater analytical data indicated that the concentration of benzene decreased as a consequence of ORC-Advanced® injection and the sample results of the biodegradation indicator compounds [dissolved oxygen (DO) and sulfate], indicate the decreased benzene concentration was the result of a biochemical reaction induced by the substrate. Sampling data indicate that benzene concentrations were reduced from a maximum baseline concentration of 1000 µg/L by 2 to 3 orders of magnitude and at some locations to less than method detection limits (<0.01 µg/l), thus indicating that the remediation goal was attained.

Injection of a mixture of substrates designed to achieve anaerobic biodegradation was utilized to remediate TCE and DCE dissolved in groundwater at Site 2. The substrate injection program consisted of an initial injection of Hydrogen Releasing Compound (HRC®), followed by a second injection consisting of HRC-Advanced® (lactic acid and a slow-release fatty acid polymer), HRC Primer® (quick-release lactic acid) and a consortium of microbes (principally the microbe Dehalococcoides). Groundwater was sampled prior to injection to create a baseline set of data and again at 1 month, 3 months, 5 months, and 12 months after injection. The groundwater analytical data indicated that the concentrations of TCE decreased from a maximum baseline concentration of 760 µg/l to less than 4.0 µg/l after injections. The groundwater analytical data indicated that the concentrations of 1,2-cis DCE decreased from a maximum concentration of approximately 570 µg/l to 94 µg/l after injections. The groundwater analytical data indicated that the concentrations of TCE and DCE decreased as a consequence of the injection program. The indicator compounds [DO, ferrous iron, and oxidation-reduction potential (ORP)] revealed the groundwater changed from oxygen-rich conditions to oxygen-poor conditions (depleted DO with increased ferrous iron in reducing conditions).

HYDROGEOLOGY AND HUMAN HEALTH: AN INTERSECTION FOR NUTRITION RESEARCH IN BANGLADESH


Efforts to supply clean drinking water to rural populations in the developing world increasingly depend on groundwater as a source. Widely viewed as successful in reducing risk of waterborne diseases (e.g., cholera) these initiatives have also increased human exposure to common groundwater constituents including sodium, calcium, arsenic, iron, phosphorous, and manganese. Traditionally, the bioavailability, or percentage of elements in water consumed that is absorbed into the body is considered very
low. Yet, while research has focused on the health impact of groundwater toxins, such as arsenic, data on the nutritional effects of exposure to groundwater minerals is sparse.

Despite ubiquity in the earth of many minerals required for health, human trace element (micronutrient) deficiencies are widespread. Women of reproductive age in rural South Asia are especially prone to deficiencies of elements such as iron due to combined effects of menstruation, pregnancy and a diet low in bioavailable heme iron from red meat and factors that facilitate non-heme iron absorption (ie, meat, fish, poultry, fruits, etc). Iron deficiency anemia can adversely affect maternal and infant health as well as performance and quality of life.

In Bangladesh, a movement that began shortly after independence in the seventies and continued during the “International Decade of Clean Drinking Water” in the 1980’s, has led to ~90% of the rural population acquiring drinking water from tubewells, largely free from microbiologic contamination. Subsequently in some areas, groundwater from tubewells has been found to contain arsenic, leading to a public health problem that is being intensely investigated. High iron content in ground water has also been reported in various areas; however, the degrees to which tubewell water iron is geologically distributed, varies in concentration and affects iron status and health when consumed over many years are not known.

Recently, in a large, contiguous rural area (~435km²) in northern Bangladesh (Fig. 1) with a population of over 600,000 people, a ~675m²-grid tubewell water survey was conducted by the JiVitA Project to map the extent and variation in drinking water iron. A total of 948 tubewells were surveyed, revealing groundwater iron (Fig. 2) to range from ~0 to 46.0 mg/L with a median concentration of 7.8 mg/L (IQR: 1.6, 17.6). This level compares with the usual elemental iron content that typifies the human diet (~6 mg/1000 calories). Although used daily for consumption, only 23 wells (2.4%) fell below the WHO “aesthetic limit” for iron content of 0.3 mg/L. The JiVitA research team is presently conducting a study to explore the association between exposure to iron through groundwater and iron status of women as a forerunner to examining relationships between groundwater iron exposure and health in rural Bangladesh.

**CONCLUSIONS ON THE USE OF MODEL PREDICTIONS DERIVED FROM MODEL POST-AUDITS AND RE-EVALUATIONS**

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Although many papers have been presented showing “successful” model calibrations, there are also papers concerned about the widespread use of model results in policy decisions based on validation and verification steps that do not support the purported accuracy of the model. Examples of the latter are:

- Freyburg (1988) who, based on a hypothetical model, concluded “successful prediction was strongly correlated with successful estimation of hydraulic conductivity” and “success in prediction was unrelated to success in matching observed heads under pre-modification conditions”
- Oreskes et al., (1994) who suggest that we need to admit that “a model may confirm our biases and support incorrect intuitions. Therefore models are most useful when used to challenge existing formulations”

Post-audits from two (mine) models and a re-evaluation of a (water-supply) model based on inverse modeling will be summarized in this presentation:

1. A model prepared for the purpose of evaluating mine pit lake evolution was audited after 10 years making use of parameter-estimation models not available previously. Revision of assumptions about hydraulic conductivity resulted.
2. A heat and density-coupled model was used to evaluate dewatering of a saline, geothermally-influenced mine. The groundwater modeling results were audited after 5 years using operational dewatering data. An assessment of the model’s accuracy and its decline with time resulted.
3. A 400 square mile model of three aquifers was used to assess the effects of developing a new groundwater supply on water levels and river flow rates in a river valley in the desert Southwest. Use of worst or best combinations of uncertain parameters was compared to results of an automated parameter estimation approach. Predictions and estimated uncertainty were compared for each approach.

A summary of the overall conclusions drawn from these model audits will be drawn, with potential application to other sites with similar constraints. It is shown that models are ideally used to evaluate “what if” questions, and because they are based on necessarily incomplete datasets, they cannot be verified, but rather provide probable predictions. Periodic revisions incorporating new field data can result in models that provide more reliable, long term predictions.
Managing Shorelines for Multiuse Reservoirs – Values, Goals, Objectives, and Compromises

Dr. Mark T. Murphy, Manager, Canadian River Basin Program, New Mexico Interstate Stream Commission, Albuquerque, NM

Ute Reservoir, on the Canadian River in eastern New Mexico, was constructed by the state in 1960 to supply water for the municipalities of Quay, Curry, Roosevelt, and Lea County. Because the state did not purchase the entire watershed, a variety of public and private land expectations have independently developed over the subsequent 48 years. At the time of its construction, a water-supply pipeline was envisioned that would reach from the shoreline to the cities of Clovis and Portales, Cannon Air Force Base and a variety of smaller cities and towns; however, Federal funding was delayed and the pipeline has not yet been constructed. A Congressional authorization bill for the design and construction of the water system was introduced this year but funding has not yet been found for the project. An interstate compact between the New Mexico, Texas, and Oklahoma is in place for the Canadian River. Residential development at the reservoir has blossomed and a State Park has been established creating public expectations about boating and other uses. And habitat for the Federally-listed, Arkansas-River Shiner has been found downstream of the dam. All of these expectations, court cases, plans, investments, and hydrological facts have created a wide and politically charged spectrum of stakeholder expectations. In answer to this, the New Mexico Interstate Stream Commission directed staff to develop a master plan for the reservoir and an advisory group to collect and clarify public opinion on the future of the reservoir in the most mutually beneficial way. The ISC staff has been working collaboratively with the advisory group on the goals and objectives of the plan. Our intent is to present the ISC Commissioners with a publicly acceptable vision for the master plan. At the time of the talk, the effort has been going on for a year. The lessons learned from this planning process are highly applicable to water resources planning throughout the arid Southwest.

Watershed Restoration in Southwest Florida: A Redemptive, Energetic Model

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The ongoing restoration of natural capital and ecosystem services within the urbanized Six Mile Cypress Watershed, Fort Myers, FL through scientific study, computer simulation, land acquisition, hydrological alterations, long-term system monitoring, volunteer activities, and the marshalling of public will constitutes a mutually beneficial form of exchange between humanity and the biosphere. Restoring this once pristine system feeds back energy and materials to the life support system, provides aesthetic and recreational opportunities, creates spiritual value, and yields additional forms of real wealth for both present and future generations. It therefore offers a transcendental, redemptive framework employing the abundant energies of natural systems, including those of humanity, and an expression of hope woven into an otherwise strictly rational ecological-economic tapestry. An important moral dimension is introduced as a result. System redemption, in the broadest sense, may prove viable, perhaps autocatalytic if we become open to the collective, energetic gifts of the cosmos. Earlier approaches to watershed modeling have emphasized bottom up treatment of the systems involved. The integrated, top down energy-based modeling methods of systems ecologist H.T. Odum, coupled with historically derived, bottom up scientific data suggests the possibility for a partnership with this complex watershed at multiple scales. The conceptual development of a redemptive energetic model will be considered in this paper, including energy system diagrams that illuminate connections among many aspects of the model.

Desertification and Watershed Degradation: The Role of Wildfire

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Wildfire is a natural phenomenon that began with the development of terrestrial vegetation in a lighting-filled atmosphere. It is a global-scale phenomenon that shows itself in Carboniferous period sediments from 350 million years ago. As human populations developed in the Pleistocene and Holocene epochs, mankind transformed fire into one of its oldest tools. Humans are now the primary source of forest and grass fire ignitions throughout the world. As human populations have increased and industrialized in the past two centuries, fire ignitions and burned area have increased due to both sheer numbers of people and anthropogenic changes in the global climate. Recent scientific findings have bolstered the hypothesis that climate change is resulting in fire seasons starting earlier, lasting longer, burning greater areas, and being more severe. A negative impact of prime concern in the 21st Century is desertification. This term refers to land and watershed degradation, not the immediate creation of classical deserts. It is about the loss of land’s proper hydrologic function and biological productivity as a result of human activities and climate change. It affects one third of the earth’s surface and over a billion people. In the past it was considered a problem of only arid, semi-arid, and dry sub-humid areas. However, humid zones can undergo desertification with the wrong combination of human impacts. Fire-related desertification has consequences in terms of environmental, social, and economic costs. Some of the environmental consequences are vegetation destruction, soil erosion, floods, watershed function decline, water supply disruption,
and air pollution. Some of these consequences are short-term and others operate over longer periods. This presentation discusses potentially devastating impacts and consequences of wildfires and improper prescribed fires that lead to desertification.

ENVIRONMENTAL IMPACTS OF MINING-DERIVED COASTAL SAND DUNES, CHANARAL BAY, CHILE

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Nearly 12 km² of contaminated sand dunes, located in the Bay of Chañaral, Chile, are the result of about 15 years of mining operations that released contaminated sediments to the bay. Even though the sediment release not longer occurs, the coastal winds transport the heavy metals attached to the sand grains over the town of Chañaral. This area is arid desert, with no more than 10 mm/year of precipitation. Between 1938 and 1990, more than 300 million Mg of highly contaminated residual sediments were deposited in the Pacific Ocean. The chemical analyses of the sediments have shown high contents of copper, iron, arsenic, zinc, cyanide, lead, aluminum, mercury, molybdenum, and other heavy metals. These toxic metals inside the sediments have avoid the establishment of almost any leaving been. As a consequence of the exposure to the toxic dust produced by the coastal winds, there has been a high incidence of skin, lung, and eye problems, as well as a high incidence of cancer tumors among Chañaral’s population. Even though there have been some attempts at stabilizing the contaminated sand dunes, none have succeeded. The most practical solution appears to be stabilize of the sand dunes with multiple row tree shelterbelts next to the town of Chañaral. This paper examines the hydrologic processes which formed the sand deposits and the potential remediation program.

POTENTIAL EFFECTS OF RECENT CLIMATE CHANGE ON MUNICIPAL AND AGRICULTURAL WATER SUPPLIES IN CHILE

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Agricultural and municipal water supply interests in Chile rely heavily on streams which flow from the Andes Mountains. The highly productive Copiapo agricultural region, on the southern edge of the Atacama Desert, is a major supplier of fruit and other crops for the Northern American market during winter. This region relies entirely on snow and ice-melt streams to provide irrigation water. Santiago, the Chilean capitol, is the country’s major metropolitan area with a population of 5.5 million. Rainfall that averages 420 mm/year is twice that of Phoenix. However, Santiago is very similar to Phoenix in that it has a rapidly expanding population and it relies on water supplies derived from surrounding or more distant mountain ranges. Recent changes in the climate in South America are resulting in decreased snowpacks and glacier volumes in the Andes Mountains. This paper discusses the current water supply situation in Chile in light of its growing demand for water and declines in supply due to climate change.

THE TERRAFIRMA PROJECT – APPLICATION OF GEOLOGY IN A PUBLIC SERVICE ROLE

David Norbury, Director David Norbury Limited, EFG, United Kingdom

Terrafirma products are being developed by ESA under the GMES Service Element Program. Using radar satellite technologies to measure and monitor terrain motions, the service aims at saving lives, improving safety and reducing economic costs of natural hazards. To do this, European InSAR service providers have consolidated services to provide standardised terrain measurement products for interpretation and exploitation.

The motion records show historic and ongoing movements down to sub-centimetric levels of accuracy. This enables assessment of terrain motion arising from a variety of sources. So far, the service has been concentrated on urban subsidence, mining, dewatering and landslides, but is broadening its portfolio to include flood risk, crustal deformation and volcanoes.

EFG represent the professional users in this project to help guide the direction of the project, to promote the activities of the project and to inform geoscientists as to what this technology can do to assist in delivering projects and in the protection of society.
The current aims of the project are to develop confidence in the products and broaden the appeal and application of the products. This includes combining the records with geological ground truth information, as held by geological surveys, and other sources of ground information. This will greatly enhance the usefulness of the product.

Feedback from users is a requirement of the service agreements in place, and these include reports on product quality, utility and exploitation activities. These reports reveal some common experiences, such as a need for more training and educational materials, better information on product quality and the need for a guaranteed background mission that will ensure adequate data archives into the future. These issues are being taken on board.

Training and education in the understanding, application and analysis of PSI is essential for a wider acceptance of what many practitioners see as a 'black-box' technology. Not only is PSI complex in itself, but there is also an assumption that all users are familiar with GIS, geo-referencing and map projections. There will be a third Terrafirma Training Workshop in 2009 and the education materials are being improved. There are also dedicated national training days in individual countries where interested parties, such as geologists, engineers and planners congregate to learn more about PSI and its practical application.

Terrafirma includes a Product Validation Workgroup (PVW) made up of key partners in geophysics, engineering and geodesy. The main aims of the PVW are to:

- Develop higher-level H-2 (Causal) products from early processing stage products.
- Guide product development in H-2 production, as well as reviewing all project output and reports.
- Oversee the specific Terrafirma Alkmaar/Amsterdam Validation Project.
- Compile a Product Validation Manual. This document will represent the 'Terrafirma Bible' in terms of explaining PSI, its accuracy and limitations, the range of Terrafirma products, practical application to real-life problems, exemplar case study examples and results of key product validation exercises, such as Terrafirma's own validation campaign.

What of the future of Terrafirma? The intention behind ESA GMES projects is that they eventually become part of Europe's autonomous monitoring of the environment. Although the detection and monitoring of terrain motions can be of high socio-economic value, and PSI continues to prove its worth in this regard, there are no clear policy drivers on the subject. This is one reason why only the landslide component of Terrafirma has so far been taken up within the Emergency Response Fast Track Service in FP7. It is simply mandatory to monitor various landslide-prone regions and Terrafirma can offer these services. However, there is no general policy to monitor terrain motion in areas such as towns, floodplains, mining areas, inter-seismic deformation, communication networks, tectonic tilts, sea-level rise, reclaimed areas, gas-, oil-, water-abstraction, and so on.

Terrafirma has produced its own cost-benefit analysis and shown the positive benefits for routinely monitoring vulnerable areas. It is common sense, however, that at around €40,000 per survey, needed, say, every three years, it must be cost-effective to use PSI methods to monitor all significant towns and areas where populations are at risk from geohazards. The savings can be huge in terms of remediation and better planning.

The EFG as part of the User representative body of Terrafirma are enthusiastic about the possibilities offered by the Terrafirma products as we enter an important and exciting phase. There is a library of successful case studies building, and the validity of the product in scientific terms has been established. We have been aiming to identify the users of the future – the fund holders that will see cost benefit from buying these products.

The potential users are spread across legislative and planning bodies at European, regional and national level. The EFG, as a European Federation, play an important role in lobbying the pan-European and regional organisations who contribute to initiatives and suggest appropriate technologies for achieving what society needs. Terrafirma is an appropriate technology.

Particular areas which have been identified for future focussed activities include:

- Flood protection both in coastal areas and in river basins. The monitoring of land movements due to geological processes along the extensive areas of low lying coastal areas where many people live is going to be extremely important as sea levels rise.
- Many areas of Europe are seismically active and monitoring terrain motion in these areas is relevant to civil protection. This cannot sensibly be carried out by land surveying. Terrafirma products offer the ability to monitor theses areas for seismic vulnerability and so offer a new level of protection to the public.
- The effects of mineral extraction are an ongoing hazard faced by many across Europe. The work already done in Terrafirma offers new insights into the mechanisms and timing of movement, and so these monitoring products offer better information for society to plan and control development and mitigation.
• The abstraction of fluids from the ground (oil, gas and water) for supply or irrigation affects most of Europe. The magnitude and rate of movement are better understood through Terrafirma monitoring. In addition, the re-injection of fluids (CO2 sequestration for example) will produce a new sense of terrain motion which could pose as yet unknown problems.
• The development of small scale products with simple colour coding to indicate no movement, movement up or down, or no data is being considered. Exploitation reports often refer to apparent complexity and the need for specialist input to obtain products. The availability of small scale coverage should provide entry level information to encourage potential users. Having identified the relevant small scale findings, users can look to acquire larger scale project or site specific information. Small scale products would also indicate hot spots for further study, or null spots where potential clients would be able feel more comfortable as regards terrain motion.

The Terrafirma monitoring and measurement products offer great opportunities for the geoscience community (senso lato) to provide significant input to the development of society. This will be delivered through better information on terrain motion providing the ability to control and mitigate the impact of natural hazards and their effects on society.

Without tools such as those provided by Terrafirma, the public will remain at the mercy of natural processes which will limit realisation of potential.

ARTIFICIAL RECHARGE SYSTEM IN FRACTURED BEDROCK AQUIFER
Bibhuti Panda, Ph.D., AMEC Earth & Environmental, Tempe, AZ

The availability of groundwater resources from a fractured bedrock aquifer was explored for the State Route (SR) 260 highway upgrading project between Payson and Heber in Gila County, Arizona. It was estimated that 260 million gallons (790 acre-feet) of water would be required for the project, and the peak demand was estimated to be 225 gallons per minute (gpm). A well field (the RV well field) was developed in fractured granitic rock near the west end of the project corridor, and it was estimated that the well field was capable of yielding approximately 300 gpm of water. However, groundwater modeling predicted that water levels in the well field would decline by nearly 100 feet over the life of the project, potentially impacting nearby private wells, natural springs, and streams. An innovative approach, the construction of an underground storage and recovery system, was adopted to mitigate potential environmental impacts related to groundwater withdrawals from the RV well field. Using this strategy, the well field was recharged with surface water obtained from a nearby stream (Tonto Creek) to minimize groundwater drawdown in the well field. Injection tests demonstrated that surface water could be injected into the well field at approximately the same rate that water could be extracted from the well field. A weir was constructed in Tonto Creek to measure flow rates and threshold criteria were established for the withdrawal of surface water from Tonto Creek to protect riparian habitat.

Two approximately 1 million gallon, HDPE-lined water reservoirs are used to store water within the project corridor. Approximately 9.5 miles of water pipeline are used to transport water from the pump house to the two reservoirs. Water from the reservoir located near the well field is pumped through a filtering/disinfection system and injected into the RV well field to maintain water levels in the well field. Construction of SR 260 was initiated in 2001 and the first three segments of roadway have been completed. An adequate supply of construction water has been supplied by the RV well field and groundwater level declines have been minimized with the help of recharge from surface water. Through the end of 2004, approximately 83 million gallons of water have been withdrawn from the well field and approximately 36 million gallons of water have been recharged to the well field. Groundwater levels in the RV wells have only declined 4.5 to 5 feet below their baseline levels through the period ending March 2006. The artificial recharge project has been very successful and this method can be used in other locations having similar aquifer condition.

APPLICATION OF GIS IN THE HYDROLOGY OF MINE PIT LAKE
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Open-pit mining is common in the copper and gold mining industry. Most large mine pits extend below the water table and will eventually fill with groundwater to form pit lakes. As the pit lake approaches post-closure equilibrium, groundwater and surface water inflows will be balanced by groundwater outflow, if present, and evaporation. A water balance model was developed based on the existing pit geometry, a groundwater flow equation, and assumed hydrologic input parameters, and this model was used to predict the post-closure steady-state pit lake level. The model assumed that at any point in time, total inflow into the system (i.e., precipitation, surface water and groundwater) minus outflows from the system (evaporation from the pond surface) was equal to a change in the volume of pit water. The water level in the pit over time was predicted by assuming a succession of steady-state water balance conditions over short time increments. The above water balance approach was employed to estimate the ultimate pit lake level in two open pits.
An analytical (spreadsheet and a computer program) method was employed in these studies to model the change in the water level in the open pits. The Arc View GIS program was used to obtain stage-volume-area relationships for the pits. Pit slope areas and watershed boundaries for the pits were accurately obtained using the GIS-Arc View program. The static (pre-mining) water table surface was obtained from a current groundwater contour map of the pit and surrounding area. Groundwater data were modeled using GIS computer methods (the spline method with tension variation) and the results were overlain onto a recent aerial photograph and topographic base map of the pit area. The water balance model was then calibrated using observed field data and a sensitivity analysis was performed to predict the ultimate steady-state pit lake levels.

PIECES OF A PUZZLE: WHY TRANSDISCIPLINARY SOCIO-TECHNICAL TOOLS ARE NECESSARY TO ADDRESS WATER RESOURCE POLICY

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The most challenging problems facing society today are complex, dynamic and ill-structured. Water resource problems are exemplary of these challenges spanning physical, political and disciplinary boundaries while also including vast sets of data and stakeholder groups through time. Science in the context of support for policy or management decision making, particularly those related to energy, water and other natural resources, must take multi- inter-, and even transdisciplinary perspectives to advance our abilities for identifying and implementing effective solutions.

While science is a way of knowing, information is not knowledge. The challenge we face in addressing complex problems is incorporating scientific information into the social process of decision making. Research and applications at the interface between earth sciences and policy are capable of creating structured representations of real-world problems that convert information to insight.

To do this, traditional scientific information must be connected with management and policy perspectives. Solutions are likely to require domain experts to look at a problem in a way that melds other disciplinary insight into their perspective (transdisciplinary) while adapting well-grounded methods from individual disciplines into interactive participatory decision, or planning, processes that facilitate science-based group dialogue (socio-technical).

Decision Pathway research is a framework that can aid development of tractable, transparent, and adaptive solutions. Based on empirical research, decision processes are broken into distinct components forming the basis for directed, strategic research efforts as a cornerstone for collaboration on complex resource management problems.

Using a decision pathway approach converts amorphous problems into a more structured format. This format is capable of producing a progressively cohesive body of research cooperatively across disciplines while incorporating both quantitative and qualitative aspects of knowledge about resource problems.

Ultimately, science is one of many means by which humans try to understand the world. Science-based policy dialogue can lead to improved management. The purpose of this paper is to present a research strategy that pairs traditional scientific methods with innovative socio-technical approaches, through a Decision Pathway framework to provide a cohesive approach for strengthening the integration of social and scientific considerations on the topics of water resource allocation, management and policy.

AN ANALYSIS OF EXISTING LITERATURE ON THE THREATS TO RIPARIAN ECOSYSTEMS IN THE WESTERN US


Over 440 journal articles, books and book chapters addressing threats to riparian ecosystems in the western US were analyzed in order to identify, quantify and qualify the major threats to these ecosystems. Publications were identified either as research, policy, literature review, historical comparison or management papers. While all papers were evaluated based on year of publication, location and types of threats, research papers were also sorted by length of study. The publications ranged from the 1960’s to the present and addressed the following threats: dams, pollution (point and non-point), grazing, land use change, timber harvesting, water diversion, road construction, recreation, mining, groundwater pumping, invasive species, climate change, salinity, fire, insect and diseases, woody encroachment, watershed degradation, and elimination of native vegetation. While the types of threats vary on spatial and temporal scales, some persist through decades in the entire western US. A detailed analysis and break-down of which threats predominate when and where will be presented.
MONITORING AND ASSESSMENT OF AIR POLLUTION EFFECTS ON FOREST IN THE SIERRA ANCHA EXPERIMENTAL FOREST, ARIZONA

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The International Co-operative Program on Assessment and Monitoring of Air Pollution Effects on Forests (ICP) was launched in 1985 under the Convention on Long-range Transboundary Air Pollution of the United Nations Economic Commission for Europe (UNECE) due to the growing public awareness of possible adverse effects of air pollution on forests. ICP Forests monitors the forest condition in Europe, in cooperation with the European Union using two different monitoring intensity levels. The first grid (called Level I) is based on around 6000 observation plots on a systematic transnational grid of 16 x 16 km throughout Europe. The intensive monitoring level comprises around 800 Level II plots in selected forest ecosystems in Europe. Currently 41 countries participate in the ICP Forests. In 2007 the US Forest Service has chosen to set up a synthesis network of 18 sites throughout the US with an ICP Level II platform at each site. Each site will include a NADP weather station, UV Radiation Monitors and Ozone Sensors. The Sierra Ancha EF was chosen to be part of this network, because it is the most southern EF in the contiguous US and because it is downwind from one of the nation’s largest metropolitan areas – Phoenix, Arizona.

GROUND-WATER FLOW FOR THE COLORADO PLATEAU AND ADJACENT BASINS SIMULATED USING THE NORTHERN ARIZONA REGIONAL GROUND-WATER FLOW MODEL

Don Pool, USGS, Tucson, AZ, Kyle Blasch, USGS Arizona Water Science Center, Tucson, AZ

The availability, occurrence, and movement of water in the arid and semi-arid regions of northern and central Arizona is primarily dependent upon the aquifer systems that underlie the Colorado Plateau within the study area, the upper and middle Verde River watersheds, and the Salt River basin. In cooperation with the Arizona Department of Resources and Yavapai County, the U.S. Geological Survey constructed a three dimensional digital ground-water model to describe the ground-water flow system. The study area covers approximately 140,000 square kilometers of Arizona, New Mexico, and Utah and includes such prominent features as the Colorado River within the Grand Canyon, Salt River, Little Colorado River, and Verde River.

Ground-water flow was simulated with a three-dimensional digital steady-state and transient model. A novel recharge surface for the region was created using a basin characterization model that was calibrated using base flow and run off data from gages within the model domain. Parameters were estimated through calibration of the ground-water model using methods available in MODFLOWP. Historic hydraulic heads and discharge values were used as the primary observations for comparison with simulated values. The three-dimensional transient model was used to compare historical measurements and to estimate future changes in the ground-water system. Initial head conditions used in the transient simulations were derived from a steady-state solution of hydrologic data starting in 1939. Transient simulations were divided into 5 to 10-year increments from 1940 to 2005. Results from the model are useful for locating ground-water divides, zones of capture and ground-water flow paths.

GEOLOGICAL MAPPING IN SPAIN: A COST BENEFIT ANALYSIS

R.Rodriguez-Fernández, ICOG, Madrid, Spain, M.Regueiro, ICOG, Madrid, Spain

The Geological Survey of Spain (IGME) developed from 1927 onwards the first series of the Geological Map of the country at a scale of 1:50,000. When the last sheet of this first series was printed in 1971, 40% of the 1,180 sheets total coverage had been completed. The MAGNA Plan for a systematic geological mapping, was designed between 1968 and 1970 to develop the second series of the Geological Map of Spain at a same scale. The aim was to provide the country with a geological infrastructure that was homogeneous in quality, worked out with the most up-to-date methods, and published in a format and with norms that were standardized. In the evaluation and budgeting of the MAGNA, consistent criteria were used, including factors such as geological difficulty, accessibility and climate. Each sheet of the MAGNA has three different documents: the Geological Map, the Geomorphological Map and the explanatory Report, along with Complementary Documents, which consists of a map of sampling locations, detailed stratigraphic columns, thin sections, hand specimens, and fossil samples, with databases for every study, photographic album, complementary reports and chemical analyses. In the 32 years that the MAGNA Plan took to be completed, about 638 geologists and mining engineers, and over 400 specialists belonging to more than 20 engineering firms, 11 Schools of Geology or Mining Engineering, and two regional geological services, as well as the staff of the Institute itself, took part in its development. It should be noted that each geological sheet of average difficulty requires the full-time dedication of 1.8 geologists per year. This figure includes laboratory and field work and back-up from experts in the various geological disciplines. All this input implies a cost per sheet of around 100,000 euros, making the total investment in the Plan 121.27 million euros.
The social and economic evaluation of the MAGNA Plan, adopted a very similar methodology to that used by the Illinois Geological Survey (USA) for the evaluation of the detailed geological maps of the State of Kentucky. A total of approximately 1,200 current or potential users of geological maps were asked to fill in a questionnaire. We think that the reply ratio of about 26% gives a sufficiently broad sample of MAGNA sheet users. The various users polled included mainly experts active in engineering, universities, mining and hydrocarbons, and also in Government bodies and the environmental, construction and agricultural sectors.

The profits or benefits from the MAGNA Plan, understood as the savings that users made on account of their use of the maps, were assessed at a minimum of 1,255 million euros and a maximum of 3,34 million euros. The cost/benefit ratio of the MAGNA Plan runs in a range from 10.35 to 27.54. It is true that the calculation was subject to the intrinsic uncertainties of such a survey and to the fact that it was not known how many copies of the maps have been sold to companies. It is also true that the evaluation was simplified by the assumption that users’ appraisal of the sheets in the year 2003 can be extrapolated to other years. Despite all this, the results are undoubtedly a conservative estimate since, as it was explained above, on two major issues a decisions were taken to use the low end figure in the estimation of the number of sheets sold, and the assumption that each copy bought by a company was used in just one project.

At any rate, it can be concluded that the MAGNA Plan, with a cost-benefit ratio of 19, was an excellent public investment. It greatly exceeded the expectations projected in the National Mining Research Plan original economic evaluation reports.

**A WORLD FEDERATION OF PROFESSIONAL GEOLOGISTS: WHY THE WORLD NEEDS ONE**

Manuel Regueiro, ICOG, Madrid, Spain, González-Barros

The idea of a WFPG was originally presented in the 1st International Professional Conference in Alicante in 2000, and later retaken in the 32th International Geological Congress held in Florence in 2004. But so far this has only existed in that form, an idea. Today scientist worldwide discuss the effects and solutions of Global Warming, and debate about how science can help to prevent, safeguard and solve the dilemma of living in an everyday apparently most dangerous planet.

In the professional global world we discuss also on how to abate barriers for mobility of professionals, how to certify qualifications, how to attain decent salaries and how to behave ethically on this evolving and harsh scientific/professional environment where opinions can represent millions of expenditure in the wrong or the right way.

Geoscientists and geoprofessionals are sometimes of the same opinion and some other times not so. But both our judgments are needed because there is nobody as unsafe as an ill-informed citizen. It is in this framework of an evolving science and an evolving professionalism to a more global view of the earth sciences involvement with society, and in the framework of the International Year of the Planet Earth, that it seems that an idea must become a reality NOW.

In 1999 after Katrina and its catastrophic results it was clear that the geological profession had to do more than acquainting, registering and documenting the phenomenon, our ethical guidelines could not and should not make us look another way. That ethical engine drove to the creation of the first geologist NGO World Geologists. Today that idea is running freely and the organization is operating in Central and South America and in Africa, developing hydrogeological and geological hazards protection projects, has a budget over 1 M€ and has employed since its creation more than 100 geologists.

If that idea has been successful, why not try now a more global professional organization?

What would that new entity do for the rest of the world?

It would of course represent professional geologists in all international forums, but specifically in worldwide organisations such as UN, ICOGS, UNESCO, IUGS, etc, it could promote and encourage the use of geological knowledge on a world wide basis to improve human welfare on the context of sustainable development, promote the integration of geology and its professionals in society to provide quick response to all its needs, promote geologically educated citizens from primary levels, improve the quality of geological professionals enhancing continual professional development at a global scale, divulge the practical use of geological knowledge at all levels, particularly employing new modern technologies, develop a global code of ethics and enforce its use world-wide, and promote global policies with regards to environmental geology, land-planning and use of natural resources, just to list some of the immense possibilities we could face.
Representatives of National Professional Associations, Regional Professional Associations, Federations of Professional Associations, Scientific and Technical associations, Earth Sciences NGOs as well as Institutions, organizations and companies interested in supporting the activities of the WFPG for the advancement of professional geology could join efforts in this new but needed view from inside the profession to outside the profession providing the citizens of the world with the geosciences they need.

**MONITORING GRAND CANYON SPRINGS AS AN ASSESSMENT OF WATER RESOURCES RESPONSE TO CLIMATE CHANGE AND GROUNDWATER WITHDRAW**

Steven E. Rice, Grand Canyon National Park Science Center, 2D McKee Bldg. Grand Canyon, AZ 86023

Spring flow from regional and local aquifers is a critical resource to Grand Canyon National Park. Spring discharge is seen as a singular response to the hydrologic character of a much larger area and an indication of the status of the supplying aquifer systems. Climate change in concert with groundwater developments on the Coconino Plateau threaten springs resources along the South Rim of Grand Canyon. Planning and management for preservation and use of springs cannot be accomplished without developing a benchmark hydrologic dataset. To assess and monitor these resources, Grand Canyon hydrologists investigate the conditions and trends in water quantity and quality throughout the Park. Routine monitoring is conducted at a number of sites along the North and South Rims, and three gage stations on the South Rim have been monitoring spring discharge since 1994.

The Seasonal Kendall (SK) test for trend was performed on spring discharge data from 1994-2007 at the South Rim gage sites to assess overall trends with time, and if these trends could be correlated to recent climate patterns. Results showed statistically significant decreasing trends at Cottonwood Creek and Indian Gardens over the period of record. The rate of decrease based on quarterly medians (-0.00042 cfs/yr and -0.004 cfs/yr, respectively) was high in comparison to the median discharge rates at these springs (0.008 cfs and 0.100 cfs, respectively), representing a 3.3% to 5.2% reduction in median discharge per year over the period of record. Results showed no distinct trend at the Hermit Creek gage site, indicating a potential difference in groundwater flow path and/or residence time for this spring system in comparison to the other two. This is supported by radioactive (14C) and radiogenic (87Sr) isotope values.

Two-component mixing models performed on oxygen isotope (δ18O) values of seasonal precipitation and spring water indicated aquifers are recharged primarily by winter precipitation (67-77% of total). This indicates that future climate changes affecting winter precipitation distribution or intensity would have a more significant impact than changes to summer precipitation on springs and their related ecosystems. The addition of increased groundwater withdraw by new residential and commercial developments near Grand Canyon would quite likely exacerbate reductions in spring discharge.

**WATER, CULTURE, POWER, AND POLITICS – WALKING THE ETHICAL TIGHTROPE OF COLLABORATIVE PROCESSES**

Craig Roepke, Deputy Director, New Mexico Interstate Stream Commission, Santa Fe, NM 87504

Decisions involving natural resources are generally both significant and difficult, in that they commonly result in long-term impacts on the environment and include contentious issues of public welfare. Over the last 20 years collaborative partnerships have become more common in natural resource management due to increasing criticism of traditional management by state and federal agencies pursuing their own mandates (Sabatier et al., 2005, p.3) Collaborative decision-making processes typically involve face-to-face negotiations among a variety of stakeholders within relatively consensual decision rules. Sabatier et al., 2005, p. 19) observe that “Collaborative institutions are really an experiment in democratic governance within the context of American federalism.” Sabatier et al., p. xii) also identify ethical concerns that include: how collaborative decision-making processes should be structured; how science should be incorporated; how well participants represent the interests associated with the policy issues of concern; what topics are included for discussion or decision; and the overall implications for community welfare and environmental quality (Sabatier et al., 2005)

A democratic process implies that the viewpoint of each individual (or interest or stakeholder) should be afforded equal significance and weight in the outcome. Such an egalitarian valuation may be appropriate where the desired outcome is a consensus on policy or general direction. However, successful resolution of natural resource issues must fundamentally rely upon the laws of physics and the natural functions of ecology and these imperatives are not susceptible to amendment or construction by consensus. Natural resource decisions or initiatives not grounded in sound science will ultimately fail in a real world application. In a collaborative process, the potential exists that success could be defined less on the basis of scientific validity than on attainment of a consensual agreement. Whether a collaborative partnership can deliver the necessary skill and insight Aldo Leopold (1999, p. 164) felt critical to protecting the environment, or the foresight C.P. Snow (1961, p. 84) feared lacking in
modern governmental initiatives addressing human needs, are vital questions that a natural resource manager should answer before embarking upon a collaborative process.

This discussion addresses these concerns within The Rio Costilla, Gila River, Rio Hondo, and Eagle Nest Reservoir processes that ranged from virtually no collaborative partnering to fully inclusive collaboration; the technical and ethical challenges encountered in each; and how choices involving participation, process, selection and utilization of data and information were ultimately made.

**RESISTIVITY AS A RECONNAISSANCE TOOL FOR LAND SUBSIDENCE POTENTIAL**

Michael L. Rucker, P.E. AMEC Earth & Environmental, Inc., Tempe, AZ

Land subsidence due to groundwater decline is a process of consolidation of subsurface materials, especially in basins. As significant groundwater decline occurs, the subsidence process initiates and proceeds. Typically, finer grained alluvium has a potential for significantly greater consolidation than coarser grained alluvium. Bedrock typically has relatively little to no practical consolidation potential. Various measurement types, ranging from repeat surveys of elevation using optical or GPS techniques, to the recent development and implementation of satellite-based Interferometry by Synthetic Aperture Radar (InSAR), can detect and monitor such subsidence as it progresses. However, subsidence has to be in process for such measurements to detect changes in land surface elevations. If, in a given area, groundwater decline has not yet occurred, and consolidation of subsurface materials is not in process, then no land subsidence can be measured. Reasonable assessment of the potential for future land subsidence in areas with no past or current groundwater development, and no subsidence history, is a difficult and highly uncertain proposition. Yet, as land development moves into previously unutilized areas, and exploits groundwater resources in those areas, land subsidence may become a geologic hazard to such development.

Since subsidence is most commonly a phenomenon occurring in alluvial basin materials with significant consolidation behavior, characterization of those materials and their geometry is essential to begin to understand future subsidence potential. Unexploited basin areas may not have any deep well log records to provide even sparse point data on depth to bedrock and highly simplified alluvial material lithology. Existing geologic mapping and basin-scale characterization using gravity methods may provide at least generalized conceptual information on bedrock-alluvium geometries to assess where subsidence may or may not be anticipated. Deep exploration drilling is very expensive point specific data collection that would appropriately be obtained as part of the groundwater resource testing and development process.

Surface resistivity methods can measure subsurface material parameters useful for reconnaissance-level assessment of subsidence potential. Very subsidence-sensitive finer-grained alluvium materials containing clays typically have low resistivities, while saturated coarser grained alluvium materials typically have moderate resistivities. Unsaturated coarser grained alluvium and bedrock typically have high resistivities. With appropriate equipment and cabling in undeveloped areas, resistivity arrays capable of penetrating several hundred feet into the subsurface can be deployed. The author has performed deep resistivity measurements for several subsidence studies in Arizona. Excellent correlations between basin alluvium resistivities and subsidence rates or magnitudes have been obtained. Where possible, comparisons with deep well downhole resistivity logs and subsidence have also been made. These empirical correlations, combined with relatively inexpensive reconnaissance field measurements, can be a useful tool to assist in assessing potential future land subsidence in areas where basin characterization is lacking.

**STRATEGIES TO SUCCESSFULLY RECRUIT AND RETAIN WOMEN GEOScientISTS**

Mary Anne Holmes, Laurie E. Scheuning, PG, CPG, AWG, Glens Falls, NY

Employers are increasingly aware of a mounting cost of doing business: the brain drain of highly trained and proficient women from their workforce. Women are achieving 30% of the PhDs awarded in the geosciences and 40% of the Bachelor’s and Master’s degrees, yet these high numbers are not reflected in the employee composition of academia, state, federal or private workplaces. A 2004 survey by Hewlett and Luce of 2,443 women and 653 men with post-graduate education (Harvard Business Review, 2005) revealed that four in ten women leave the workforce for childbearing, eldercare, personal and health reasons. A nearly unanimous 96% return to work, either because they find work so rewarding or because of financial necessity. The average duration of their out-of-work phase was a mere two years. Put into the perspective of an entire career (a 2005 AARP study found that 1/3 of Americans aged 60-69 are still working), this is a short leave. Men also take time off from work: twenty-five percent leave for career training or to switch careers. Increasingly, men cite family needs for taking leaves from work. Goldman Sachs calculated the cost of a lost, trained employee: 150% of the employee’s annual salary to hire a replacement. Bringing well-trained people in whom a company has already invested back into the workforce makes good business sense.
A recent study by Hewlett and others (Harvard Business Review, 2008) looked at the disproportionate brain drain in the science, engineering, and technology (SET) fields. This study was initiated in response to the comments by the then-president of Harvard University, that women were not well represented in the sciences because they lack what it takes to excel. The data were based on surveys of 2,493 workers (1,493 women and 1,000 men and many others interviewed in focus groups). The study found that women enter SET professions in considerable numbers (41% of entry-level workers in SET fields are women) and continue to do well throughout their early career. However, 52% of women drop out around age 35 to 40; twice the drop-out rate for men in these fields and higher than the rate for women in law and investment banking fields.

The report (sponsored by Alcoa, Johnson & Johnson, Microsoft, Pfizer, and Cisco) found that the reasons women leave SET jobs are varied, but are dominantly related to the unsupportive and discriminatory male-dominated culture. The report details sexual harassment, dismissive attitudes of male colleagues, lack of mentors, and unsuitable working hours as reasons for leaving their jobs.

We can reframe work leaves as natural parts of human life and focus on the wealth of experience, knowledge, expertise, and teamwork the returning worker brings to the table. Many companies have instituted successful strategies to re-employ returning workers (on-ramps) and to keep workers employed at less than fulltime for brief periods (off-ramps). The most successful strategies address the entire arc of the worker’s career and do not focus solely on childbearing years. We already know that some working women want maternity leave and daycare for young and school-age children. Women and men need on-ramps back into the workforce whenever an illness or family emergency arises. As Hewlett writes in “Off-Ramps and On-Ramps” (2007), successful strategies to retain women in the workforce include: 1) a rich menu of flexible work arrangements rather than a one-size-fits-all policy, 2) an arc-of-career flexibility sensitive to eldercare and other family contingencies, 3) reimagining work life by offering employee assistance, as needed, 4) helping women claim and sustain ambition through leadership and networking initiatives, 5) harnessing altruism for company charitable efforts, and 6) reducing stigma and stereotypes of nonlinear career paths by whole-hearted support from the top of the organization.

Ernst and Young may be the poster child of successful flexible work arrangements (FWAs), offering: a) compressed workweeks (a workweek fewer than five days), b) flextime (vary start and stop work times each day), c) reduced-hour schedules (fewer days/week or fewer hours/day), d) short-term seasonal arrangements, e) job sharing, and f) telecommuting. These FWAs are available to every employee throughout his/her work life, and may be stopped or started as works best for both the employee and employer. BT Group and Citigroup also offer multiple types of FWAs.

Arc-of-career flexibility can be revolutionary and incite creative thinking about the way work can get done rather than how it gets done now. Work tasks currently thought of in bundles may be parcelled into pieces that can be done by part-time workers (e.g., proposal writing; data crunching). Face meetings can be scheduled during school hours rather than during after-school pickup/delivery times of pre-school and school-age children. Booz Allen Hamilton’s Adjunct Program provides high-impact, part-time work for people at any stage in their careers. Lehman Brothers’ Encore program provides returning workers with get-you-back-up-to-speed seminars that can lead to part- or full-time employment with Lehman. Goldman Sachs has a similar program called New Directions.

Citigroup, Time Warner and Johnson & Johnson offer their employees assistance for eldercare and for non-nuclear family members. The latter is particularly important for some ethnic and racial groups of people who routinely care for extended family members. These companies are successful because they began by assessing the needs of the employees and implemented feedback loops to ensure needs are being addressed.

Other companies are implementing programs that are designed to retain and promote women in the SET fields. Programs at Cisco and Johnson & Johnson teach women leadership skills and provide them with mentors and roles models in an attempt to increase the number of women in management.

The single unifying reason why these strategies have begun to bear fruit for these companies is buy-in from the senior management to reduce stigma that employees may feel by using nonlinear career strategies. An unflagging message of support from above, rewarding excellent part-time employees, offering the strategies to all workers at all stages of the career, are all key ingredients to minimizing the brain drain. Reducing the current attrition rate of women by 25% would add approximately 220,000 SET workers to the economy.

Eighty percent of women physical scientists are married to another scientist or engineer, whereas only about half of male physical scientists are married to another scientist or engineer (National Academy, 2006). Employment for a spouse will be an additional issue when trying to recruit women geoscientists, particularly outside of major metropolitan areas.
Tracking hires, leaves, and retention at the University of Colorado for the last ten years, Marschke and others (2007) demonstrated with differential calculus that doing nothing to increase recruitment and retention will result in never achieving a proportion of women in the workforce that is equal to their production rate at the Master’s or PhD levels. Active intervention is necessary. Making the workplace more human-friendly, providing short-term off-ramp options and vigorous on-ramp recruitment are necessary to increase the numbers of women in geoscientific endeavors. Companies can work together to share strategies, and each company will find a best-fit for their own corporate culture.

WATER DEMAND UNDER URBAN HEAT ISLAND AND CLIMATE CHANGE IN TUCSON, ARIZONA, 2000-2006
Christopher Scott, Assistant Professor, Udall Center for Studies in Public Policy, University of Arizona, Tucson, AZ, Eve Halper, Stephen Yool, Andrew Comrie

Urban warming resulting from the combined processes of urban heat island (UHI) and climate change has important implications for water demand. This paper relates residential water use in Tucson, Arizona with increased temperatures derived from weather station data and geospatial analysis of vegetation and temperature using Landsat Thematic Mapper imagery. The rate of urban warming is greater than the regional warming trend and is more pronounced in Tucson’s urban core than in the still-urbanizing peripheries. The study concludes that UHI is an important but not singular driver of water demand. Regional water planning must also account for: a) residents’ choice of landscape vegetation type, b) outdoor irrigation practices that are only partially based on the vegetation's water requirements, and c) broader public perceptions that water conservation may allow for additional growth.

TESTING THE CLIMATE FOR NON-POTABLE WATER REUSE: OPPORTUNITIES AND CHALLENGES IN SOUTHERN ARIZONA
Christopher A. Scott, Assistant Research Professor, Udall Center for Studies in Public Policy, and, Assistant Professor, Geography & Regional Development, University of Arizona, Anne Browning-Alken, Senior Researcher, Udall Center for Studies in Public Policy, University of Arizona, Kerri Jean Ormerod, Research Assistant, Udall Center for Studies in Public Policy, and M.A. Candidate, Geography & Regional Development, University of Arizona

Adaptive water resources management in water-scarce regions facing climate variability and economic growth requires innovative approaches to the complex and interlinked requirements of water law, public opinion, ecosystem services, and water quality. This paper reviews the evolving practice and regulation of water reuse (treated effluent) in the Southwest United States by specifically considering under which environmental and institutional conditions reuse is most likely to be incorporated into water resources planning. We examine the influence of climate change and variability, economic growth, and urban water supply and demand on water reuse decision-making by exploring the institutional climate of regional water and effluent planning. In the high-growth Sun Corridor in southern Arizona effluent is used in the Santa Cruz, Tucson and Pinal Active Management Areas; however, the potential conflicts between growth limited water supply, and climate variability are only partially addressed. In-depth consideration of public perceptions of reuse and substitution of effluent for existing (potable water) uses will contribute to sustainable water management in this region.

SPRING WATER RESOURCES – A CASE STUDY FROM KATHMANDU VALLEY, NEPAL
Pramod Simkhada

Kathmandu Valley is an intermontane basin in the centre of a large synclinorium of the Lesser Himalaya. It measures approximately 30 km in EW and 25 km in NS directions leading to a nearly circular outline of the basin.

The spring water resources in south-west part of Kathmandu Valley are potential for irrigation, drinking and industrial uses. The quality of springs is generally good. This paper encapsulates the story of the springs and efforts to control by building good management of them. Rapid increase in population, lack of proper conservation and poor management, the water supply of Kathmandu Valley has become inadequate. Attempts have been made to tap groundwater by constructing deep tubewells in various parts. Present water supply could not meet the demand of the city, so the people are trying to use other sources. In this regard, an attempt has been made to understand the quantity, quality and present management status of the water supply from some aquifer zone (Spring Water) in the south-west part of Kathmandu Valley which can be utilized for domestic needs.
The limestone beds (Chandragiri range) of Precambrian to Devonian age are distributed in south-east and south-west region of the valley, which are intensely folded, faulted and fractured. The numerous springs from limestone karstified zone covers the area at about 50 sq km. The springs originate at the slopes and base of the mountains are mostly from the fractured limestone beds. Total yield remains unchanged throughout the year and these hard rock zones may have enough potential to supply the present water demand in the valley. An appropriate technology has to be applied in limestone terrain so that it could be an alternative source for supplement of water supply and could reduce the problem of water demand in Kathmandu Valley.

THE SIGNIFICANCE OF CONTINUING PROFESSIONAL DEVELOPMENT AND CREDENTIALS UPON CAREER OPPORTUNITIES

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Data show that a majority of practicing geologists hold a Masters degree. Regardless of the specialties chosen by the respective practitioners, statistics and anecdotal evidence show that advanced degrees, continuing education activities, and other credentials actually enhance career prospects for the practitioner.

Career choices are affected by numerous subjective requirements (i.e. employer defined position requirements) and legislative/regulatory impositions. The practitioner must balance job (not to mention personal) obligations with activities which increase career opportunities and choices.

Activities which present professional choices and requiring thoughtful consideration include requirements related to: continuing education (explicit in some state registration requirements or necessary to maintain other credentials); inter-jurisdictional mobility; international practice requirements; inter-society cooperation; etc.

Each practitioner must evaluate which extra curricular activities are most suitable to one’s career expectations. A review of the possible options demonstrates possible affects upon one’s career as a consequence of active engagement in various extra curricular activities.

HOW PREDICTABLE IS THE CLIMATE SYSTEM: DROUGHTS, FLOODS AND EXTREME EVENTS?

Soroosh Sorooshian, Ph.D., N.A.E, Distinguished Professor, Civil & Environmental Engineering and Earth System Science Director, Center for Hydrometeorology and Remote Sensing (CHRS) The Henry Samueli School of Engineering, University of California-Irvine

The recently published IPCC (Intergovernmental Panel on Climate Change) report has provided convincing evidence that on the average, our planet is warming up at an accelerated rate and for the first time, IPCC has suggested there is a link between anthropogenic activities and the resulting warming trend. The recent report has also pointed out that our current understanding and modeling capabilities fall short of providing information about regional trends and changes, particularly in the case of precipitation. Hydrologically speaking, recent literature, as well as the recent IPCC report, argue that with the global warming the hydrologic cycle shows evidence of intensification, particularly in terms of the frequency and magnitude of hydrologic extremes such as floods and droughts.

Considering the link between climate, hydrology, and water resources, the following two questions seem appropriate to be asked. First, how will climate effect water resources availability and second, can we predict the future changes which are responsive to “user” needs. To provide some insight into the above questions, this presentation will start with a review of the current practices in factoring climate and hydrologic extremes into the water resources planning. The role of traditional engineering approaches to incorporating climate variability into the design and operation of water resource systems will be discussed. The importance of stochastic hydrology in the engineering approach will also be addressed. It will be argued that much of the stochastic hydrologic analysis which relies on the use of probability distributions generated from instrumental records falls short of capturing the non-stationary nature of the hydrologic fluxes such as rainfall and runoff.

To demonstrate the issue of the non-stationary nature of hydrologic time series, the observations of instrumental period (100 years, or more) will be examined in the context of the longer historical data obtained from proxy information such as tree rings and isotope analysis.

In the final part of the presentation, some results related to prediction of future regional trends and variations in hydrologic variables, such as precipitation and runoff, obtained from climate and hydrologic models will be discussed. The role of state-of-the-art observation technologies from remote sensing and in-situ instruments will be highlighted. While we still have a long
journey ahead of us towards achieving satisfactory prediction of future hydrologic regimes at all time and spatial scales the regional progress to date towards this goal has been encouraging. Examples specifically in the context of Western United States will be provided. It will be argued that while we wait for the capabilities of models to improve sufficiently to provide hydrologic predictions useful for the user community the water resources planning should rely on building sufficient resiliency into the plans to cope with the uncertainties associated with future hydrologic extremes.

THE ASBOG® FUNDAMENTALS AND PRACTICE EXAMINATIONS: THE DEVELOPMENT AND ADMINISTRATION OF A NATIONAL EXAMINATION

Richard K. Spruill, Ph.D., 2008 ASBOG® Secretary and Chair, ASBOG®
Committee on Examinations, Grimesland, NC 27837

The Mission of the National Association of State Boards of Geology (ASBOG®) is to serve as a connective link among the individual state geologic registration licensing boards for the planning and preparation of uniform procedures and the coordination of geologic protective measures for the general public. One of ASBOG®'s principal services is to develop standardized written examinations for determining qualifications of applicants seeking licensure as professional geologists. State boards of registration are provided with uniform examinations that are valid measures of competency related to the practice of the profession. Examination candidates are provided with a copy of the Professional Geologists Candidate Handbook which delineates the format and outline for the examination.

ASBOG® administers the Fundamentals of Geology (FG) and Practice of Geology (PG) Examinations twice each year. The FG and PG examinations were developed to access common knowledge and skills related to the practice of geology throughout the nation. The FG examination emphasizes knowledge and skills that are typically emphasized in undergraduate academic programs, and the PG examination emphasizes skills and knowledge acquired and expanded in a practice or job setting. Participating states administer each “closed-book” examination during a four-hour period. Both examinations are constructed using a four-option multiple choice form, and the FG and PG examinations contain approximately 130 and 100 items, respectively.

Both examinations are based on the results of periodic task analysis surveys that are designed to evaluate the current geologic practice. Task analysis surveys were performed in 1995, 2000, and 2005 by collecting data from a random sampling of licensed geologists from each of the ASBOG® member states. The results of all three task analysis studies indicate a high degree of consistency in the practice of Geology throughout the United States, thereby establishing a sound basis for the development of examinations that are fair to candidates from all regions of the country. Geologic tasks were rated by both practicing geologists and academicians in terms of the importance of the specific tasks to protection of the public, and the results of the survey were utilized to create test blueprints for both examinations that temporally and geographically reflect the practice of the profession. Established Content Domains for the FG and PG Test Blueprints (effective October 2006) are listed below:

Percent of Items by Domain

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<td>B. Mineralogy, Petrology, &amp; Petrography</td>
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<tr>
<td>C. Sedimentology, Stratigraphy, &amp; Paleontology</td>
<td>14</td>
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<tr>
<td>D. Quaternary Geology, Geomorphology, &amp; Surficial Processes</td>
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<td>E. Structure, Tectonics, &amp; Seismology</td>
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<tr>
<td>F. Hydrogeology &amp; Environmental Geochemistry</td>
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<td>G. Engineering Geology</td>
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<td>H. Economic Geology &amp; Energy Resources</td>
<td>7</td>
<td>16</td>
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<td>TOTALS</td>
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From the first administration of the examinations in October 1992, through the examination in March 2007, 9,541 candidates completed the FG Examination and 7,443 completed the PG Examination. The average passing rate across all administrations of the FG is approximately 58% and is 71% for the PG. Based upon an analysis of reliability coefficient, the examinations have performed extremely well across time.

Beginning with the March 2008 examination, ASBOG® initiated a new program designed to capture important information regarding examination candidate educational background and degree programs. The long-term goal of this program is to provide important statistical information to Geoscience programs nationwide regarding the performance of their graduates. Individual Geoscience departments may elect to utilize this information in a variety of ways, including exit examinations, and/or accreditation.
Natural hazards have been present since the early times of mankind: the eruption of Vesuvius or the Lisbon earthquakes are well known examples, but it is today when the growth of the population and its interaction with the physical environment that such hazards become more evident. In the last few years news about natural catastrophes are common, and the brutal earthquake suffered in China just this same month with more than 50,000 dead, is a horrifying example.

Spain is not excepted from this hazards as we can mention the flash flood that destroyed a camp ground in Biescas (Aragón) in 1996, the flood of Badajoz in 1997 or the 2007 floods in Alcázar de San Juan which entrained severe economic losses.

Land use planning with the modern tools available should look into the future and not so much into the historical analysis, and should try to avoid or prevent such risks. Such prevention, aside from saving human lives, can also serve to reduce the economical losses, which in Spain, according to a study carried out by the Geological Survey of Spain recently account for 0,5 to 1% of its GDP.

In order to try to reduce the economical and social impact of natural hazards, the first step is to know the typology, magnitude and distribution of the hazards, thus geological hazards maps in land use planning are the basic tool for the prediction, study and solution of this problems and the use of this maps is fundamental in emergencies management.

The new Land Law, passed last year, includes a provision for compulsory natural hazards studies before any land planning can be approved, and this is a first but major step to mitigate or even avoid that such natural effects can cause economic and social problems to society.

Is in this sense that the Ministry of Housing of the Government of Spain has launched the publication of a Methodological Guide for the Elaboration of Maps of Geological Hazards, with the objective of fulfilling the requisites of the Land Law. Such guide has as main objective to establish the methodology and procedures to elaborate geological hazards maps, so that once vulnerable zones are located for a certain hazard, a more rational distribution of the use of the land studied can be achieved.

Thus, once the potential hazards have been located, we will be able to differentiate which areas are not so suitable to establish certain activities and which are able to support others, due to the fact that they are not prone to suffer catastrophic hazards. The Methodological Guide for the Elaboration of Maps of Geological Hazards will be the reference tool for professional working in this field (urban planners, politicians related with urban planning and land-use planning, municipal, autonomic or other administrative urban officials, specialists in charge of land-use planning programs, geological hazards experts, etc.

The guide will thus have the following objectives:

- To define and typify broadly the main geological hazards and locations in the Spanish territory. Such locations will alert the users of the guide on the potential natural hazards of a certain zone
- To establish the necessary conditions to develop a regional and local scale analysis to know the topography, magnitude and distribution of the hazards which will represent the basic knowledge of all the hazards in a territories to be used as base document in the urban planning programs as well as a consulting instrument for citizens.

Such maps of geological hazards will determine if the areas which are going to be subjected to planning procedures, are located in areas prone to be affected by natural hazards and will establish its zoning and classification.

The Energy and Water Efficiency Benefits of Distributed Recycled Water Production Facilities

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Trevor T. Hill, P.Eng., Global Water Resources, Phoenix, AZ

Water and energy are inextricably linked. Moving water, heating water, treating water are each enormously energy intensive. Further, the very production of power consumes vast quantities of water. In an ironic twist, as the world reaches deeper into the ground for water supplies, and moves farther afield to access water, getting that water to where it is needed requires more power, which in turn requires more water.

Water scarcity and the energy intensity of water are placing extreme pressure on natural resources and power systems throughout the world. That water/energy nexus – the link between power and water – demands that the most power efficient systems be deployed first, and then augmented by power intensive technologies for only the minimum volumes associated with potable water production.
That most efficient water resource is recycled water. When deployed as an element of a regional planning initiative, using recycled water can consume 25% to 50% less power than single plumbed, all potable, systems. For a 70,000 unit development, the resultant cumulative energy savings are in the order to 11% of the entire energy budget for the community. This reinforces the water savings of water recycling which can reduce the community water consumption by as much as 60%.

**EVALUATING SURFACE WATER AND GROUNDWATER INTERACTIONS IN A STRESSED AQUIFER SYSTEM USING AN ECOHYDROLOGICAL APPROACH**

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David R. Mattimore, David C. Niemeyer, Alan Cathcart

Ecohydrology involves an integrated approach to determine the interactions of the groundwater, surface water, and wetlands to the withdrawal of groundwater from an aquifer. The development of a new groundwater well as a public water supply historically involved a relatively uncomplicated technical and permitting process. However, as environmental concerns have increased, site evaluations and associated permitting requirements have taken on a new and more complicated appearance along with a much higher project development cost.

An ecohydrological approach was used for the development of a new groundwater source in the Town of Concord, Massachusetts. The Town needed to develop a new groundwater source in response to a growing population. A suitable location was identified adjacent to the Concord River, a major river that flows through the town. Preliminary groundwater exploration indicated that the proposed site was capable of yielding one million gallons per day.

Of interest for the ecohydrological approach was that the site contained two historically important ponds, the Concord River, potential vernal pools, and both rare and endangered species (both flora and fauna). To address these site complexities, an aquifer pumping test plan was developed for this site that included a three well withdrawal configuration, 33 groundwater observation wells, 7 piezometers, and 8 staff gauges. After the aquifer pumping test was completed, the thickness of the organic layer was measured along the bottom of several suspected vernal pools and two of the ponds.

The results of the aquifer pumping test and resource area monitoring indicated minimal impacts to the Concord River, ponds, and suspected vernal pools. Two of the three rare and endangered species were identified at the site.

The withdrawal of groundwater from this site was maximized and adverse ecological impacts minimized as a result of implementing an ecohydrological approach for developing these new groundwater wells. Short and long-term monitoring of the aquifer and overlying water resources is recommended to validate this approach.

**WATER BALANCE APPROACH TO RAINFALL-RUNOFF MODELING IN NORTH CENTRAL ARIZONA FORESTS**

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One major issue in hydrology is the change of rainfall to runoff. There are a number of ways of converting rainfall to runoff: some are simple such as the lumped parameter approaches of the NRCS or the rational methods of determining rainfall-runoff relationships. Others are more complex such as the event-based, spatially varied water balance approach to estimating runoff from precipitation presented in this paper. We use data from one of the Beaver Creek watersheds, the Bar M watershed to develop the event based, spatially varied rainfall-runoff model. The various input variables used in the model represent different hydrological and climate processes. They include precipitation, canopy interception, evaporation, transpiration, snow accumulation and melt, solar radiation, infiltration, soil water storage and surface runoff. A geographical information system (GIS) is used to subdivide the watershed into cells of homogenous biophysical watershed characteristics such as slope, aspect, elevation, canopy cover and soil type. The amount of runoff produced in each cell is computed using a water balance model, then the runoff is routed downstream from cell to cell in a cascading fashion to estimate the total amount of water yield from the watershed. The model estimated water yield for the cold and warm seasons are 105 mm and 4.3 mm which are 22% and 1.9 percent of the total seasonal precipitations, respectively. The seasonal variability in water yield is mainly due to seasonal variability in climate and the form of precipitation that occurs.
AN INTERNET SURVEY OF ACADEMIC SCHOLARSHIPS OFFERED BY U. S. GEOSCIENCE PROFESSIONAL ORGANIZATIONS AND FOUNDATIONS: TOTALS, RANGES, MEANS, MEDIANS, MODES, MODELS, MOTIVATIONS, AND DISAPPOINTMENT (DATA NOT AVAILABLE)

Robert E. Tepel, AEG-CSMGB, San Jose, CA

Introduction. Attracting students to our profession is a basic goal of professional membership organizations and their related foundations. They do it by providing information about the profession, inviting student participation, and offering financial incentives (scholarships).

Question: What are US-based geoscience professional membership organizations, and their related foundations, doing to provide academic scholarships to degree-bound high school, undergraduate, and graduate geoscience students? Here I report results from an internet-based search for those scholarships.

Method: I searched six tax-exempt organization databases and two scholarship databases for the key words earth science(s), geological, geologist(s), geology, geophysic(s)(al), geoscience, groundwater, and ground water. Results were reviewed for scholarship content, and augmented by study of the web sites of member societies of the American Geological Institute, and of sections, divisions, and chapters of six large geoscience, mining engineering, and petroleum engineering associations.

Results: I found 66 entities that offered academic geoscience scholarships, or offered scholarships in closely related fields that were also open to geology majors. Of these, 33 grant only “fixed value” scholarships (announced with specific dollar values), 21 grant only “variable value” scholarships (announced with no specific dollar value promised), five grant both fixed and variable value scholarships, and information was lacking for seven organizations. Age of most recent data varies; data for recent years were composited to synthesize an “annual” picture.

Analysis: Sufficient information for simple statistical analysis is published by grantors for 31 of the fixed scholarship programs. These 31 organizations grant 183 scholarships in a composite year, with a total value of $246,900 and a mean value of $1349. The median value falls in the $1,000 group. Range of scholarship value is $200 to $5,000. Value distribution is tri-modal, with peaks at $500, $1000, and $2000.

Sufficient information for simple statistical comparisons is published by nine of the 26 organizations that grant variable value scholarships. These nine grant 634 scholarships in a composite year, with a total value of $1,361,156 and a mean value of $2147. Range of scholarship value is $100 - $10,000.

Think About: How do scholarship values compare with the cost of education? Is it enough? Do we know how many scholarship recipients stay in the profession for 10, 20, or 30 years? Are our organizations and their donors receiving a reasonable return on their investment? What can we do better?

THE PRACTICABILITY AND IMPRACTICABILITY OF CERTIFICATION

Robert E. Tepel, AEG-CSMGB, San Jose, CA

The concept of credentialing includes all methods of formal third-party attestation as to the qualifications of a person to perform certain tasks. Licensure, certification, and registration are credentialing methods that are applied to the geosciences and other fields. Current usage in the social sciences provides primary definitions of licensure and registration as functions of government, and certification as a function of business (including business leagues = professional organizations.) Many geologists have not adopted the social science definitions of credentialing terms, but should because they are the reference points for legislators and regulators.

Is certification practicable? That is, can it be put into practice? Clearly, yes, it can be put into practice. Six professional membership geoscience organizations in the United States offer certification to their members. Four of the six have a complaint resolution process by which any person may allege wrongdoing by a certificant. Three of the six organizations link their certification to the protection of the public. The rigor of certification processes varies. Four organizations offer certification without written examination. Two organizations offer certification based on written examinations, and furnish their examinations to states licensing their disciplines.

The root question for all certification in the geosciences is simply this: does it do the job it is advertised to do? One suspects that most certification programs do not live up to the hopes of their founders because market penetration (percent of potential certificants who are certified) is low. Discipline rates under the four certification programs with complaint resolution processes hover very close to zero. They are ineffective in protecting the public.
Geoscience professional organization certification is practicable in that it offers business value to a small proportion of practitioners, and, amongst a limited population of practitioners, it encourages a sense of duty to the public. Geoscience professional organization certification has proven to be impracticable as a way to assert and protect the public interest in the practice of the profession. A multi-decade dearth of reported disciplinary actions is evidence that certification does not remove inept or unethical practitioners from the field, and therefore does not fulfill the objective (if claimed) of protecting the public interest in the practice of the profession. Perpetually low enrollment in certification programs that have complaint resolution processes, combined with almost non-existent complaints, suggests that certification programs are not enrolling those who need them most.

THE EFFECTS OF SAND AND GRAVEL MINING ON LOCAL GROUNDWATER CONDITIONS, WASHTENAW COUNTY, SOUTHEAST, MICHIGAN

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Most hydrogeological investigations associated with the mining industry in the United States are conducted as a necessity of the state or local permitting process, and not made readily available to the public or become published for use in the industry. As a necessity of the permitting process and to provide additional data to the industry, the recent evaluations of an ongoing groundwater monitoring program associated with an active sand and gravel mining operation is presented here.

A sand and gravel mining company located in southeastern Michigan has been extracting material from below the water table in an unconfined aquifer since the mid 1990’s. Mining both above and within the saturated zone is conducted with the use of draglines and more recently, a floating clamshell dredge. Dewatering to artificially lower the water table is not conducted as part of the mining methods. Final reclamation plans include the creation of three lakes ranging in aerial extent from approximately 4 to 35-acres and depths ranging from 25 to 110-feet below the mean water table. Currently, one lake is being constructed at a rate of approximately 2-acres/year. To date, the lake is approximately 22-acres in area and averages 45-feet deep. Two additional lakes, one of approximately 23-acres and one of 4-acres are planned to be completed within the next 15-years. The groundwater hydrology has been characterized through a growing monitoring well network since 1995. Data evaluations include fluctuations in the shallow water table elevation, groundwater flow direction and water quality since mining began within the saturated zone. The monitoring well network shows that the local groundwater flow direction continues to be to the southeast. More recently, the sampling of domestic potable water supply wells has been conducted and provides water quality data from the surrounding residents. The ongoing evaluation has shown that no significant changes have occurred in the flow directions or water quality of the subject aquifer. Water quality data continues to reflect baseline conditions. Mining and ground water monitoring will continue for several years. As data becomes available, additional reports can be evaluated and presented to document the groundwater conditions while the surface water bodies are being created.

WATER WELL REHABILITATION IN BOTSWANA, AFRICA

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Botswana is located in the Sub-Saharan Region of Africa, an area characterized by an arid climate, limited availability of surface water, and heavy dependence upon ground water resources. In the 1980’s, the Department of Water Affairs (DWA), the national water utility in Botswana, drilled hundreds of water wells throughout the county to provide towns and villages with potable ground water. Roscoe Moss Company (RMC) manufactured and supplied a large portion of the well screen that DWA installed in those new wells. In the 1990’s, DWA curtailed its well construction activities, and simply continued to operate the wells. Little or no attention was given to maintaining the wells, so eventually their capacities diminished and their well efficiency declined.

DWA eventually recognized that it needed to restore the production capacity by rehabilitating the wells, but the utility had neither the experienced staff nor the equipment to do so. DWA turned to RMC and requested technical assistance. This led to the development of a plan for a pilot project to redevelop wells within the country. With funding from the United States Trade and Development Agency (USTDA), RMC, and DWA, a pilot well rehabilitation program was launched. The program was formulated for RMC to train and supervise DWA personnel to rehabilitate its wells by mechanical methods and chemical cleaning. RMC sent several of its personnel to work with DWA beginning in January 2007. Following an initial training program, two crews of DWA personnel began the rehabilitation of 35 wells. The final few wells are currently being cleaned with completion expected in late July 2008. RMC will present the results of the project in a final report that will be submitted to DWA and USTDA in November 2008.
Nitrate is a common contaminant in ground water in Arizona, exceeding maximum contaminant levels (MCL) in many regions of the state. Recently, Arizona Department of Environmental Quality (ADEQ) bolstered the Aquifer Protection Permit (APP) rules with provisions intended to reduce or eliminate sources of nitrogen pollution to ground water. For example, for areas with existing or potential contamination that will contribute to exceeding nitrate thresholds from the Aquifer Water Quality Standard, ADEQ has established a process to designate “Nitrogen Management Areas” to authorize controls and regulations for nitrogen sources. To support implementation of this important regulatory approach and other management strategies, the University of Arizona developed a multivariate logistic regression model to predict the probability of nitrate concentration in ground water.

Drinking water and other water quality data was joined directly with well location data, with a final data set of 6,802 wells across the state with unique locations, IDs, and associated nitrate data. Working within a GIS platform, well location data was used to map and attribute a table of physical characteristics from existing data sources, such as land use, soils, geology, population density, precipitation, proximity to point-source nitrate contributors (such as Confined Animal Feeding Operations – CAFOs), and slope. Data as to the density of septic systems (a common nitrate source) was not available so several approaches were used to predict septic nitrate sources. To map the state, we created a polygonal grid at 1,500 meters (approximately 0.9 square mile) and attributed the grid with the attributes of the various data sets that were used in the analysis, for a total of 274,945 points across the state. Using predicted probabilities we generated three probability maps for Arizona, showing aquifer vulnerability to nitrate at 3, 5, and 10 mg/L nitrate-N. The GIS and logistic regression analysis described in this study effectively inform decision-makers as to the magnitude, extent, distribution, and uncertainty of current and anticipated nitrate risks. It identifies areas where ground water have been affected by human activities, and it will help regional and local water managers protect water supplies by targeting land-use planning solutions and implementing monitoring programs where ground water may be vulnerable.

CONSULTING GEOLOGY AND THE ROLE OF LICENSING

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The geologic profession consists of a diversity of specialists who are and will continue to be of importance to the world-wide community for their knowledge of geologic resources, structure and processes. As the global economy expands and contracts with changing conditions and resource needs, the geologic profession may also be affected. This may result in changes to fundamental geological education, specialty education and experience within the profession. For example, during the 1970s and 1980s there was a large growth in environmental geology while petroleum geology had a downturn. This caused a significant number of geologists practicing in petroleum geology to shift their practice to environmental geology. These changing conditions in turn, contribute to a highly mobile and often international geologic work force, with varying backgrounds. Global mobility will continue to increase and therefore it is important to have a mechanism for not only assessing minimum competency, but also a mechanism to address geologic work that incorrectly or incompletely applies geologic principles that may affect public or private health, safety or welfare. The more these mechanisms are developed between countries, the easier it will be for consulting geologists to maintain their mobility and for the public to benefit from access to a wide variety of highly competent professionals and the interaction of a diverse pool of geologists. Licensing in many forms is one of these mechanisms. To a lesser extent, professional geologic organizations during their review of presentations or publications by consulting geologists are another.

A case study summarizes one example of why these mechanisms are important. It illustrates how the incomplete and erroneous interpretation of geologic information would have prevented the protection of the public and groundwater resources. This occurred because of the following:

1. undefined and inconsistently applied standards of practice for the characterization of the geology,
2. incomplete consideration of the scale of the geologic understanding that was necessary for an adequate understanding of the site geology, and
3. development of conclusions and recommendations for site development that were unsupported by the geologic data collected.
Potential international goals that are desirable to address these situations include:

1. definition and minimum standards for education and experience within the geologic profession,
2. the development of a preventative system (for example a combination of education, experience and testing) for evaluating minimum competency, and
3. the development of an in-country and an international organization to facilitate the competency of geologic practice and address incompetent practice in a curative way.

IN-SITU SENSOR MONITORING OF AQUIFER RECHARGE STORAGE & RECOVERY

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Everyday water resources become more scarce in the United States and around the World. Due to continuing population growth and movement within the United States, certain municipalities and water providers are moving to aquifer recharge, storage and recovery techniques. Aquifer Storage and Recovery (ASR) systems can store large amounts of water deep underground and can reduce development of expensive surface reservoirs. Aquifer storage eliminates evaporative losses typical of surface water reservoirs and offers better protection and water quality. ASR systems may restore and expand the function of an aquifer that has experienced long-term declines in water levels due to heavy pumping conducted to meet growing urban and agricultural water needs.

The injection and recovery of water supplies have both hydraulic and geochemical effects on an aquifer. The real-time and continuous monitoring of ASR and artificial recharge is essential in determining the effectiveness of an ASR system and its impact on aquifer systems. In-situ sensor technology is essential to the permitting process, hydrogeological analysis, water quality monitoring, aquifer interaction, and regulatory reporting requirements. The advancement of sensor technology in the last decade can provide a majority of the hydraulic and chemical data needed to design, monitor and operate an ASR system.

SOUTHERN DROUGHT AND THIRSTY ATLANTA REKINDLE TENNESSEE / GEORGIA BORDER DISPUTE

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Colonial Georgia extended westward to the Mississippi River. Its territory encompassed the big bend of the Tennessee River where it dips south out of Tennessee. In 1802 Georgia ceded its western lands to the United States as the Mississippi Territory, the northern boundary of which was identified as the 35th parallel. Georgia’s western boundary was then set so that its northwestern corner would coincide with the place called Nickajack on the Tennessee River, thus retaining Georgia’s riparian position with respect to the Tennessee River. By Act of Georgia’s legislature, the northern boundary separating Georgia from its neighbor Tennessee was established as the 35th parallel. However, as a result of error, probably due to inferior equipment, a survey in 1818, established a line that was proclaimed to be the boundary between Georgia and Tennessee, but it was actually drawn approximately one mile south of latitude 35° N. It was not until years later that the error was realized. By that time, those people who would be affected by a correction would have nothing of it, especially those Tennesseans who would become Georgians. At various times over the better part of two centuries, repositioning of the Georgia/Tennessee boundary has been argued, most vigorously by the government of Georgia. Georgia wants the land (approximately 72 square miles) between the present boundary and the 35° N lat. Aside from the personal inconvenience that would have to be borne by the inhabitants of the contested region if a border correction was made, the most significant outcome of the error of 1818 is that the current boundary places Georgia just out of reach of the waters contained in the Tennessee River and the large TVA reservoir at Nickajack; and, Georgia needs water. As Atlanta grows, the demand for water is becoming too much for the small Chattahoochee River, and major drought conditions of 2007 elevated the problem to crisis proportions. Consideration has been given to obtaining water from the also smallish Savannah River or developing desalinization plants on the Georgia coast, but the better solution lies with bountiful waters of the large Tennessee River. In February of 2008, after reviewing its border history, seeing Google Earth’s images of the proximity of the water and the location of the 35° N latitude running through the middle of the Nickajack reservoir, the legislature of Georgia proposed to take a new and strong position with respect to demanding a return of the disputed property from Tennessee. A flurry of huffy political talk ensued. This debate is expected to bring in the U.S. Army Corps of Engineers, TVA, Georgia Power, state and local governments and others to determine the fate of Georgia’s desire to extract large volumes of water from the Tennessee River. Georgia’s request has thus far been denied due to the absence of riparian rights to the river, which because of an error in 1818, nowhere touches the state of Georgia. Such a border dispute in the 21st Century seems unrealistic, but Georgia is serious, at least about the water. This paper will review the current controversy and briefly examine the feasibility of a Georgia water supply from the Tennessee River.
As population centers continue to expand throughout Arizona, societal demands are changing the flow regimes of many rivers and altering spatial patterns across the water landscape. Today, a new hydrologic dynamic has emerged as water consumption for growing urban development is increasing the generation of wastewater effluent and its discharge into stream channels or aquifers. As of 2008 Arizona has approximately 40 waterways designated as effluent-dependent. We present an analysis of the changing spatial patterns of effluent discharge and development of effluent dependent waterways over the past thirty years in Arizona using historic aerial photography and treatment plant discharge data. We also present a framework for categorizing the fate of municipal effluent. One aspect includes the intended use of the effluent; here, we quantify the degree to which effluent is 1) re-used directly, 2) recharged to aquifers for later re-use, or 3) used to create or sustain wetland/riparian habitat. We also categorize effluent discharge with respect to hydrogeomorphology of the receiving water bodies, recognizing that each type has different capacity to sustain hydoriparian vegetation. Our categories include 1) ephemeral channels within an endogenic dryland river; 2) channels of perennial or spatially intermittent rivers; 3) stream (alluvial) aquifers, and 4) regional (interbasin) aquifers. Over the coming decade both the number of municipal discharge points and the total effluent discharge is expected to increase, intensifying the need to understand ecological implications of effluent dependent systems.

In the 2004 Arizona Water Settlements Act Congress apportioned New Mexico an additional 14,000 acre-feet per year of water from the Gila and San Francisco Rivers for use in New Mexico, along with non-reimbursable federal funding. While expenditures up to $66 million can be used for a variety of planning and environmental compliance, mitigation, and restoration projects, funds between $66 million and $128 million must be used only to develop some or all of the 14,000 acre-feet of additional water for New Mexico in the Gila Basin. The New Mexico Interstate Stream Commission adopted a policy to use the best available science and information, coupled with a full and inclusive public involvement process, to both protect the unique and valuable ecology of the Gila Basin and to provide for present and future water needs.

This paper will discuss the unique stakeholder engagement process and the opportunities for mutually supportive projects in the area, as compared to traditional governmental project planning. The public formed a Stakeholder Group that is open to anyone interested. The group has no leadership, but as a whole gives direction to its committees, including technical, implementation, and collaborative modeling. The Stakeholder Group will make recommendations to the Interstate Stream Commission on how, or if, the water and money should be used. A Process Framework developed by the Bureau of Reclamation to assess water resources in the planning region and evaluate the alternatives to use New Mexico’s benefits provides an initial process and schedule for arriving at the Stakeholder Group recommendations.

The group harbors much distrust, based on historically one-sided actions of state and federal governments as well as perceived conflicts between the desires of environmentalists, agriculturalists, municipal water users, and other stakeholders. The Interstate Stream Commission is working to change the dynamic, beginning with the open stakeholder process, and by creating awareness of the potential for mutually supportive projects. Projects could include gravity-fed diversions, off-stream storage, habitat improvement areas, and virgin research streams. Projects could simultaneously provide municipal and agricultural supply, fire protection, and environmental benefits from recharge, improved habitat, and protection and supplement of instream flows.

The activities of the National Association of State Boards of Geology (ASBOG®), founded in 1990 to facilitate the licensing of professional geologists, include:

- developing and administering national licensing examinations,
seeking to bring compatibility to the procedures used in various states in the licensing process, and
developing and providing information for the approximately forty-thousand registrants within the 28 states
and Puerto Rico which are members of ASBOG®.

Professional ethics is one of the issues that ASBOG® considers of critical importance in the professional practice of geology. To
promote and implement consideration of professional ethics, the following elements have been either adopted or are under review
for adoption:

- code of ethics for the membership of ASBOG® (adopted),
- guidelines for the enforcement of the ASBOG® code of ethics (adopted),
- ASBOG® member participation in workshops on professional geological ethics (adopted),
- collection and publication of information on activities of individual boards and professional ethics (adopted),
- ASBOG® Strategic Plan includes provisions to enhance professional ethics (in development),
- continuing consideration of the desirability and practicality of including questions on professional ethics on
  the national licensing examinations (in development), and
- encouraging presentations at national and international meetings emphasizing the importance of professional
  ethics in geological practice (adopted).

Typical of the information collected from state Member Boards is the compilation of the penalties that can be imposed by
licensing boards in their efforts to enforce ethical standards. These include monetary fines, required continuing education,
suspension or revocation of licenses, and criminal prosecution. Most states publish often on Web sites the actions taken against
member registrants for ethical violations.

ROLE OF REMEDIATION HYDRAULICS IN GROUNDWATER
RESTORATION: ACCOUNTING FOR REALISTIC AQUIFER BEHAVIOR

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Fred Payne Ph.D., Vice President, ARCADIS, Novi, MI
Joe Quinnan PE, Principal Engineer/Hydrogeologist, ARCADIS, Brighton, MI

Successful groundwater restoration projects can increase the supply of groundwater available for residential, commercial and/or
industrial use. Existing groundwater resources that are not currently usable due to chemical impacts from historical industrial or
agricultural land use can be made available with groundwater remediation. For a groundwater remedial technology to succeed, it
is important to re-evaluate our fundamental understanding of aquifer behavior as it relates to groundwater flow and solute
transport. Traditional data analysis and interpretation methods do not provide a sufficient level of detail to support accurate site
conceptual models and remedial system design. The following aspects of remediation hydraulics support this position: 1)
anisotropic groundwater flow – high-resolution aquifer characterization results suggest that a very large fraction of groundwater
flows through a very small fraction of the aquifer volume, in many aquifers less than 10 percent of the aquifer (the “mobile
porosity”) carries more than 50 percent of the flow; 2) groundwater velocities – actual groundwater velocities within the “mobile
porosity” are typically much higher than aquifer average values as determined from traditional hydraulic analysis, leading to
longer plumes and larger investigation efforts; 3) near-zero transverse dispersivity – a wide solute plume typically indicates that
the source area is poorly characterized and is much larger than a single point, or that the plan-view hydraulic gradient is variable.
The correct application of these concepts leads to a better site conceptual model, and ultimately results in more successful and
cost-effective restoration of groundwater resources.

THE INFORMATION AGE, GLOBALIZATION AND GEOSCIENCE ENTERPRISE:
OPPORTUNITIES, CHALLENGES AND THE IYPE BEYOND 2009

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Sometime around 1970, the Information Age became a catch phrase for which a Google search will now reveal numerous
specific dates and definitions. However one defines it or the date assigned to its beginning, the explosion of electronic technology
and communication, and the attendant widespread availability and use of the internet rapidly advanced the “globalization” (again
variably defined) of many commercial, industrial and educational activities including geoscience enterprise. Geoscience
enterprise, as I define it, includes professional practice in education/academe, private sector industry ranging from independent
individual practitioners to large international corporate organizations, public/governmental agencies and organizations through
local, state, national and international entities.
Because a major product of all geoscience enterprise has historically been (and remains) data/information/knowledge/wisdom, it should not be surprising that the Information Age and globalization has brought many new opportunities and challenges for professional practitioners. This presentation will provide the author’s ponderings and views on some of them.

The International Year of Planet Earth (IYPE, 2007 – 2009) was initiated by UNESCO and the International Union of Geological Sciences (IUGS), with the central year (2008) proclaimed by the UN General Assembly as the International Year. At this writing, about 70 countries around the globe have formed National Committees to implement the mission, goals, objectives and programs of the IYPE. By year’s end, I suspect that number may grow to 80 or perhaps even more. With this large global network of geoscientists thus established, we in the global geoscience community face the opportunities and challenges as to how to best utilize this organization and network beyond 2009 to move forward to realize the full potential of the Year’s lofty subtitle, “Earth Sciences for Society.”

GROUNDWATER AND SOLUTE TRANSPORT NUMERICAL MODELING USING GIS OF THE EASTERN COAST OF CAP-BON (TUNISIA)

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The aim of this thesis is to identify the main sources of groundwater salinisation of the Eastern coast of Cap-Bon, to optimize water management.

First we had identified the degradation of the aquifer characteristics, then we had been interested in the identification of the main sources of the salinisation problem.

To this end, we proceeded to:
- hydrochimical mapping and detailed description of the aquifer characteristic evolution (piezometric levels, salinity),
- analysis of the available hydrochimical maps,
- identification of the main sources of groundwater salinisation.

The interpretation of hydrochimical data had shown that:
- a serious lowering of the water-table levels,
- a serious deterioration of the groundwater quality,
- the sea water intrusion is the principal source of the salinisation of the groundwater.

In order to validate our analysis, SEAWAT, model simulate the salt water intrusion. Several simulations had been done and had four aims:
- determination of the hydrodynamic characteristics of the aquifer,
- quantification of the quantity of the water which enters the field of discretization (natural, artificial refill...) and that which leaves it (exploitation, drainage...),
- determination of the direction of the flows of subsoil water in the aquifer,
- simulation of the advance of the salt particles and the transport of dissolved body.