The 3rd Hydrogeology PPG minutes

University of Miami, Florida, February 25 - 26, 2001

Participants

PPG Members:
John Bredehoeft, The Hydrodynamics Group, USA
Earl Davis, Geological Survey of Canada
Shemin Ge (Chair), University of Colorado, USA
Steve Gorelick, Stanford University, USA
Pierre Henry, Ecole Normale Superieure, France
Henk Kooi, Vrije Universitiet, The Netherlands
Allen Moench, U.S. Geological Survey, Reston
Martin Sauter, University of Jena, Germany
Peter Swart (Host), University of Miami, USA
Tomochika Tokunaga, University of Tokyo, Japan
Fiona Whitaker, University of Bristol, UK

ESSEP liaison:
Liz Screaton, University of Florida, USA

Guests:
Keir Becker, University of Miami, USA
Barbara Bekins, U.S. Geological Survey, Menlo Park,
Kevin Brown, Scripps Institution of Oceanography, USA
Carolyn Ruppel, Georgia Institute of Technology, USA
Willard Moore, University of South Carolina, USA

Regret:

Clifford Voss, U.S. Geological Survey, Reston

Minutes

Guest Presentations

Presentations by Keir Becker, Carolyn Ruppel, and Willard Moore filled the main agenda of the morning session on February 25. Keir Becker briefed the group on the IODP schedule, and explained the structure of the interim and future panels and committees. He also brought the Initial Science Plan document to our attention.

Carolyn Ruppel's presentation followed and focused on gas hydrates. Following a brief introduction of the basic structure of gas hydrate, distribution of discovered gas hydrate deposits, and the stability diagram, she presented her research results on the dynamics of gas hydrate formation with application to the Blake Ridge gas hydrate. A one-dimensional fluid and dissolved gas transport model was used to identify the stability regime and formation zone of gas hydrate. A main conclusion of their study is that a significant amount of fluid flux is required in order to explain the discovered gas hydrate. Yet, current understanding of the fluid flow regime is quite limited. Insights into the hydrogeology at the gas hydrate sites, particularly the fluxes of fluid, dissolved methane, and energy, are necessary in order to understand the dynamics and location of gas hydrate formation.

Willard Moore presented his research on groundwater mixing between meteoric water and seawater in coastal aquifers. The distribution of chemical tracers, such as ^{226}Ra and ^{223}Ra, in the coastal ocean was mapped. These tracers originate within coastal aquifers and reach the coastal ocean as the surface and subterranean systems exchange fluids. Consequently, these fluid exchanges may be quantified by examining the tracer distributions in the coastal ocean. Examples from the East and Gulf Coasts of the U.S. were used to evaluate the importance of these unseen estuaries in supplying not only chemical tracers, but also nutrients, to coastal waters. Anthropogenic effects such as ground water withdrawal on subterranean estuaries are causing significant change to these systems. The group asked questions on scale and applicability of this research to broader coastal regions.

Discussion of Scheduled Legs

Since the first hydrogeology PPG meeting in 1999, routine collection of hydrogeologic data from all legs has been repeatedly suggested. To maximize possible data collection opportunities, in the afternoon on February 25, the group discussed three scheduled legs that are still at the planning stage: 201, 203, and 204. Leg 201, which will drill into the Peru Margin, is biosphere-focused. Since the current plan does not include hydrologic data collection, Shemin Ge plans to communicate with the proponent to explore the possibility of considering the addition of hydrological measurements to the leg. Leg 203 will drill into the Costa Rica subduction zone to develop an understanding of the processes associated with seismogenic zone, fluid flow, and temperature characteristics. The group discussed fluid flux and temperature measurements related to the leg. Earl Davis will convey our discussion to the co-chiefs. Leg 204 will drill into the Hydrate

Ridge in the Cascadia. The group suggested they make appropriate hydrogeologic measurements. Kevin Brown will communicate this suggestion and related discussions to the appropriate scientists working on that leg.

Status of the Final Report

The rest of the afternoon on February 25 and most of February 26 were devoted to the content of our final report. The content outline was modified and a revised outline emerged near the end of the two-day meeting. Although a working draft was put together prior to this meeting, much more in-depth discussion took place at the meeting, and we felt that it would be necessary to have four more months to write sections incorporating the latest discussion into the report. The original SCICOM timeline for the Hydrogeology PPG was to submit the final report to SCICOM at its 2001 spring meeting scheduled on March 21-23. We would like to request the deadline be extended to July 31, 2001. A considerable amount of discussion was devoted to the recommendations. The following offers a summary of the main scientific questions and a preview of the recommendation section of our working-in-progress final report. The table of contents of the final report is attached at the end of the minutes.

Key Scientific Questions

We recognize and emphasize that fluids play a vital role in virtually all subsurface processes. Fluid flow is an effective agent in transporting heat and solute. Coupled fluid and heat transport has important implications in studying hydrothermal systems in middle oceanic ridges, deep fluid circulation in subduction zones, energy budget in gas hydrate zones and deep biological communities, and thermogenic fluid in carbonate platforms. Understanding submarine mass transport is critical in quantifying fluid fluxes between oceans and lands, contributions of dissolved gas flux into gas hydrate zones, nutrient supply to the biosphere, and chemical transport and diagenesis in carbonate plateforms. Fluid presence has a strong influence on mechanical processes in sediment compaction in accretionary wedges and subducting plates. The role of fluids in earthquakes is a key for seismogenic zone studies on multiple fronts. Fluid pressure is intimately linked to seismic rupture. Post-seismic diffusion of pore pressure can reveal insights into the hydrogeologic parameters of the marine sediments. Moreover, fluids in the deep subduction zone influence the rate and depth of melting, the site of volcanism. It is prudent that we consider dynamic coupling of various processes involving fluid flow in submarine geologic systems. Although the effects of fluid flow in all geologic processes are known, quantitative understanding of the fluid flow and how it couples with other processes remain elusive. We therefore imposed the following overarching hydrogeologic questions:

- What are the water budget and fluxes at global scales?
- What is the current state of the fluid: pressure, temperature, and composition?
- How is the fluid moving?
- How is the moving fluid transporting mass and heat?
- What is the past state of the fluid system—the paleohydrology?
- How has the paleohydrologic system transported mass and heat?

Discussion of Measuring Techniques

We had an extended discussion on measuring techniques and the appropriate tools used to obtain reliable measurements of temperature, formation pressure, permeability, stress, and fluid sampling. Temperature measurements are often good indicators of fluid flow processes. There are major problems with the present techniques, either reliability of inherent problems with the tool, e.g., the fracturing of the sediment that the ADARA tool is injected in thereby inducing equilibration with the temperature of the seawater. Future improvements are deemed necessary. For measuring formation pressures, the standard techniques using the drill stem test require an additional trip to the bottom of the hole. Standard packers attached above a drill bit are often destroyed by the mud circulation. It should be possible to develop a drill stem test tool with a mechanical packer placed above the bit that is operated by the mud motor. This type of setup would allow rapid testing of formation pressure and permeability without additional trips to the bottom of the hole and fluid could be circulated above the packer thereby ensuring hole stability.

Recommendations

1. We identified seven geologic settings where fluid flow is clearly linked to other processes such as heat and mass transport, sediment compaction, and faulting. The settings are:
- middle oceanic ridges
- subduction factory
- seismogenic zone
- coastal zones
- carbonate platforms
- deep biosphere
- gas hydrates

Details of these settings are being worked out by individuals from our group. We recommend calling for hydrogeology-focused proposals and supporting dedicated legs to study each of the above-mentioned type settings.

2. We recommend establishing long-term hydrogeologic observation stations in key settings around the globe so that we can better understand the nature and extent of water budget and fluid fluxes beneath the ocean and between oceans and lands.

3. We recommend routine collection of a basic suite of hydrogeologic measurements on all research legs. These measurements include pore pressure, temperature, chemistry, permeability, porosity, and stress. Data need to be collected at a range of scales from near boreholes to cross-hole formation.

4. We support pre-cruise modeling studies to develop a quantitative rationale for experimental design. Pre-cruise modeling can also provide a conceptual understanding of the hydrogeological systems when only limited data are available.

5. We recommend developing new and improved tools for hydrologic measurements, such as putting thermistors on the APC, wireline and drillable packer systems, improved water sampling and stored-pressure core sampler, and flux measurements at depth. We also suggest seeking engineering competition beyond the ODP community when necessary.

6. We recommend that future ODP panels and committees include more scientists with hydrogeology expertise.

7. We suggest planning and funding fluid-focused workshops to encourage broader involvement from the hydrogeoloic community.

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