Hydrogeology PPG, Minutes of the Second Meeting

The second Hydrogeology PPG meeting was held at the Ecole Normale Superirure, Paris, France on September 24 and 25, 2000. Pierre Henry hosted the meeting. The participants were

Hydrogeology PPG Members
John Bredehoeft (Hydrodynamic Group, US)
Shemin Ge (University of Colorado, US)
Steven M. Gorelick (Stanford University, US)
Pierre Henry (Ecole Normale Superirure, France)
Henk Kooi (Vrije Universitiet, The Netherlands)
Allen F. Moench (USGS)
Martin Sauter (University of Jena, Germany)
Peter K. Swart (University of Miami, US)
Tomochika Tokunaga (University of Tokyo, Japan)
Clifford I. Voss (USGS)
Fiona Whitaker (University of Bristol, UK)

ESSEP Liaison
Barbara Bekins (USGS)

Guests
Kevin Brown (Scripps Institute of Oceanography, US)
Warner Bruckmann (JOIDES)
David Goldberg (Lamont, US)

Graduate Student Assistant
Bourlange Sylvain (Ecole Normale Superirure, France)

Regret
Earl E. Davis (Geological Survey of Canada)

The two main agenda items of the second meeting were guest presentations and detailed discussions of the preliminary work plan we had laid out at the first meeting. Warner Bruckmann from JOIDES gave a presentation on the site survey data requirements. His presentation generated general discussion on the paradox of studying interesting but possibly dangerous places with unexpected high pore pressures. The discussion led to the recognition of the importance of three-dimensional monitoring. David Goldberg, representing ODP-LDEO, gave a presentation on current ODP tools for physical property measurement and the latest modular formation dynamics tester. Although the modular formation dynamic tester and other wireline packers are not currently available on ODP cruises because of insufficient inner pipe diameter, the group learned from David Goldberg their capability, operation mechanisms, and relevant hydrogeologic applications. Both guests answered many questions related to hydrological field measurements. Kevin Brown updated the group on the recent seismogenic zone meeting and major issues regarding seismogenic zone limits, stress and pore pressure state, and the nature of asperities of the seismogenic zones.

After the first PPG meeting, each of us was charged to work on certain sections of the preliminary work plan. Emails were exchanged and progress was made on several fronts as outlined in the following. The importance of fluid flow in a variety of geological processes and its relevance to ODP were articulated. The major driving mechanics for subsurface fluid flow, basic governing equations, coupling relations, system variables and parameters were discussed and summarized. Some of the members made efforts in proposing establishing a global network for hydrogeologic monitoring, characterizing spatial and temporal heterogeneity, and summarizing the state of knowledge on hydrogeologic modeling. There was extended discussion on fluid flow related processes in carbonate plateforms, ocean islands, land-sea floor connections, and seismogenic zones. These prior efforts provided a good foundation for a more focused and a better organized discussion at the 2nd meeting. The work plan was thus refined, and every PPG member, plus Barbara Bekins and Kevin Brown, was charged with assigned sections of the refined work plan. Following is a brief summary of the discussions.

Driving mechanisms and system variables

To understand the fluid flow dynamics of particular tectonic settings, we felt it prudent to identify major driving forces for fluid flow. Our discussion associated the driving forces with five tectonic settings where fluid flow is thought to play a significant role in geologic processes. In active margin settings (seismogenic zones, accretionary prisms), driving forces may include topography, thermal gradient, tectonic compression and sediment compaction, and diagenetic fluid sources. In abyssal plains, thermal convection and mechanical forces from compaction are the primary mechanisms for driving fluid flow. In passive margins and carbonate plateforms, topography, thermal and salinity gradients, tectonic compaction, diagenetic fluid sources, and ocean currents all contribute to the complexity of the fluid flow systems. In middle oceanic ridges, thermal and chemical gradients are considered major factors operating the flow systems. Finally in ocean islands, we recognized that topography, thermal and salinity gradients, and tides are responsible for driving fluid flow.

On the system variable and parameter issue, pore pressure, temperature, stress, salinity, permeability, and flux are all considered to be important to know in order to fully describe the hydrologic and related processes. They can be obtained either through direct measurement or inferred from modeling.

Case Study Areas

We proposed five areas that can best serve as case studies for a better understanding of the relevance of fluid flow in a variety of processes. They are middle oceanic ridges, active margins (accretionary prisms and seismogenic zones), carbonate plateforms, coastal zones, and biosphere. At the meeting, we focused our discussion on the main scientific questions and the major processes for each of the case study settings. Other details such as conceptual models, state of knowledge, study approaches, and types of measurement, will be worked on in the next few months.

In the middle oceanic ridge systems, major processes involve multiphase fluid flow and hydrothermal convection through heterogeneous fractured rocks. Hydration and cooling rate of oceanic crust could be better understood through further hydrologically oriented studies.

In accretionary prisms, sediment compaction and tectonic forces couple fluid flow to deformation. Problems of interest include fluid and solute mass balance, diffusive versus focus flows, and influence of spatial and temporal heterogeneity. Seismogenic zone is another area of great interest, as it has long been speculated that fluid flow plays a major role in triggering seismicity, and participates in a variety of processes in the subduction factory. Yet, a systematic and quantitative understanding of how fluid flow couples stress and strain in the active margin environment is largely lacking.

Carbonate plateforms were considered as one of the few tectonic settings where fluid flow is clearly involved in almost all the processes. Temperature and salinity distributions are affected by fluid advection. Interesting issues also include sediment compaction induced fluid flow, mass balance, diagenesis, reservoir permeability structure, and the global carbon cycle.

In the coastal zones, societally relevant salt water intrusion problem can be better addressed through a clearer understanding of the interface of fresh and surface water. Unlike submarine systems, topography driven flow comes into play in coastal zones. Anthropogenic and climate effects on land and sea connection can be further studied. Coupled stress and fluid flow study are needed to study submarine slope stability.

In biosphere and gas hydrate studies, problems of concern may include biological controls of large earth chemical cycles, flux of growth substrates and degradation products throughout systems, effects of phase change, and diagenesis. Fluid flow influences the biosphere by redistributing heat and dissolved solute.

Recommendations

We had some preliminary discussions on recommending routine measurement of hydrogeologic parameters, staffing hydrogeologists on all relevant ODP cruises, encouraging more research legs devoted to fluid flow studies, and supporting a fluid flow analyst or modeler for each of the case study areas. We recommended identifying and setting aside an appropriate amount of the research budget for such work. We suggested approaching NSF for their support. Identifying the pool of funding will be instrumental in encouraging participation from the larger hydrogeologic

community. In addition, we also discussed the possibility of holding future workshops as another way of informing the interested hydrogeology community.

Future Meeting Logistics

We proposed to request that the next meeting be held in Miami on February 25 and 26, 2001. Peter Swart has agreed to host the meeting. We would like to invite Barbara Bekins (biosphere), Kevin Brown (flux measurement), Carol Ruppel (gas hydrate), and Liz Screaton (ESSEP laison), Thomas Janecek (pressure measurement technology), Keir Becker (future IODP), Willard Moore (coastal zone expert) to attend the next meeting.

Respectfully submitted,
Shemin Ge, on behalf of the Hydrogeology PPG