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Hydrogeology and the Weak Nature of Plate Boundary Faults

There is evidence for low frictional strength along many plate-boundary faults, including the San Andreas and the Cascadia subduction megathrust. High pore pressure is a leading hypothesis to explain this behavior. Proposed mechanisms for generating excess pore pressures include consolidation, tectonic strain, metamorphic dehydration, mantle degassing, hydrocarbon generation, thermal expansion, and pressure solution. Regional-scale flow and transport models constrained by observations of fluid chemistry, heat flow, and pore pressure data can be used to test various pressure generation hypotheses. Ultimately, these results may be coupled to models of other processes such as frictional heating or strain to understand the importance of fluids.

In subduction zones, very high pressures result from rapid loading of saturated seafloor sediments during accretion and subduction. Evidence for excess fluid pressure includes direct measurements, mud volcanism, and dilated faults. The Ocean Drilling Program has installed seven seafloor wells in subduction zones. Data from the Cascadia margin off central Oregon shows that flow is both transient and focused along faults. In the Barbados complex, pore water chloride anomalies indicate that clay dehydration fluids flow from deep in the complex to the seafloor along the plate-boundary thrust. Model results constrain the duration of flow and the distance of transport. Future models will quantify deeper fluid sources, evaluate mechanisms for transient flow, and changes in pore pressure through the earthquake cycle.

Biography

Barbara Bekins obtained a B.S. in mathematics from UCLA, an M.S. in mathematics from San Jose State University, and a Ph.D. in Geology from University of California, Santa Cruz. Currently, she is a research hydrologist with the USGS specializing in transport and biotransformation of organic contaminants in groundwater. Her published work includes results from a creosote site at Pensacola, Florida, and a crude oil spill at Bemidji, Minnesota. From 1998-2000, she was a member of a National Research Council Committee on Intrinsic Remediation. The committee's report, Natural Attenuation for Groundwater Remediation, describes the capabilities of natural attenuation and the adequacy of the published guidelines for documenting its effectiveness. More recently, she has been working with the USGS NAWQA program planning studies on the fate of agricultural chemicals in the environment. In 2002 she sailed on Ocean Drilling Program Leg 201 to investigate how fluid flow provides essential nutrients to buried microbial populations in the sediments of the equatorial Pacific and Peru margin.