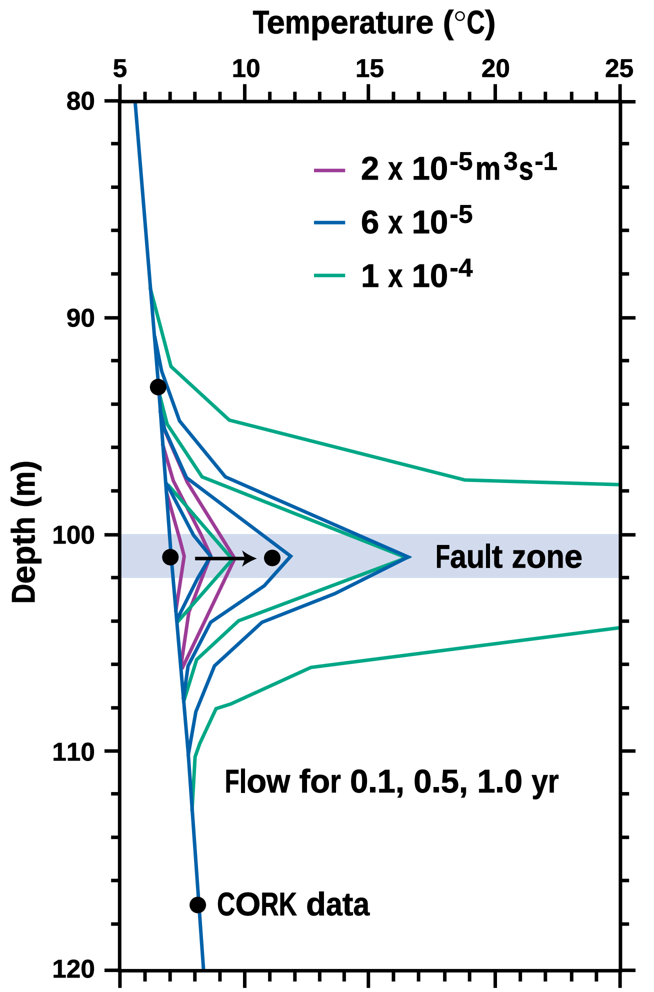
Fault-confined fluid flow on the Cascadia accretionary prism

Bobb Carson, Department of Earth and Environmental Sciences, Lehigh University
Elizabeth J. Screaton, Department of Geological Sciences, University of Colorado
Earl Davis, Pacific Geoscience Centre, Geological Survey of Canada

Accretionary prisms that develop at convergent plate margins consist of a saturated sediment wedge, whose elements are subject to compression and rapid burial. The sedimentary section is commonly overpressured and hydrocarbon-bearing fluids are expelled at the sediment-water interface. The hydrogeologic regime controls the physical stability of the prism and elemental flux to the ocean. Yet only within the last 5 years have in situ permeability and pore pressure data been collected, and only at the Cascadia margin has active flow been unequivocally recorded.

ODP Site 892 off Oregon intersected a thrust fault whose surface trace is associated with carbonate deposits, gas hydrates, and chemosynthetic biological communities which indicate active fluid migration. Downhole packer tests across the fault zone showed high pore pressure shortly after drilling ($l^*=0.4^{-<1}$, where l^* = (pore pressure - hydrostatic pressure)/(lithostatic pressure - hydrostatic pressure)) and relatively high permeability ($k=10^{-14}$ - 10^{-11} m^2; [*Screaton et al.,* 1995]). Following drilling, the hole was isolated with an instrumented borehole seal (CORK). Over the next 10 months, the pressure declined to near hydrostatic ($l^*=0$) and tests conducted from a submersible at the well indicated that permeability fell to 10^{-16} - 10^{-14} m^2, presumably as pressure-supported fractures closed. However, the CORK recorded a 4°C rise in temperature at 100 mbsf over a 5.5 month period. No change in temperature was recorded by adjacent thermistors positioned at 92 or 116 mbsf (see figure). Modeling the borehole temperature increase indicates very rapid flow (~1000 m/yr) over the limited (0.5 yr) period of observation [*Davis et al.,* 1995]. The event probably represents transient flow that characterizes fault-related, fracture-controlled flow paths in active accretionary prisms.



Numerical model of flow required to account for thermal anomaly recorded after ODP Site 892 was shut in. Temperature profiles are shown for 3 different rates of flow, and at 0.1, 0.5, and 1.0 yr after initiation of flow. From Davis et al. [1995].

References:

Davis, E. E., K. Becker, K. Wang, and B. Carson, Long-term observations of pressure and temperature in Hole 892B, Cascadia accretionary prism, *Proc. ODP, Sci. Results, 146,* 299-311, 1995.

Screaton, E. J., B. Carson, and G.P. Lennon, Hydrogeologic properties of a thrust fault within the Oregon accretionary prism, *Journal of Geophysical Research, 100,* 20,025-20,035, 1995.