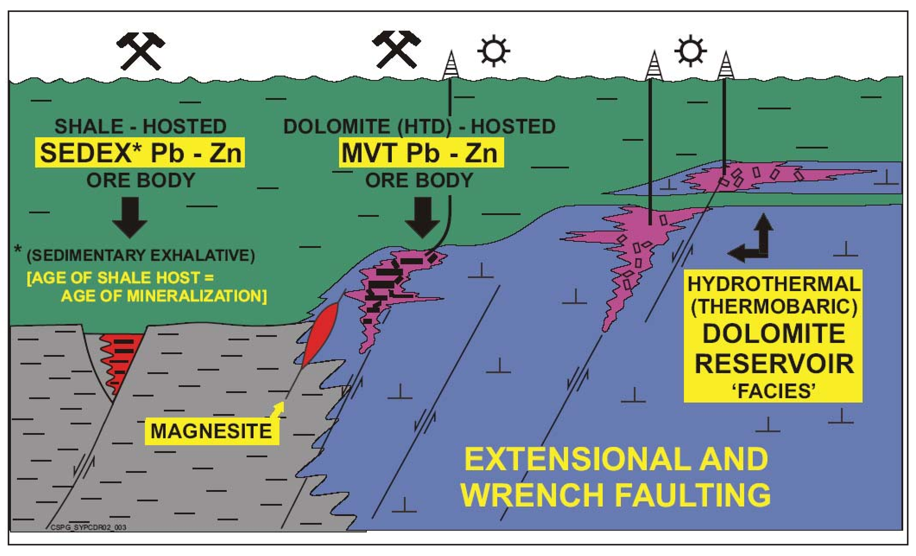
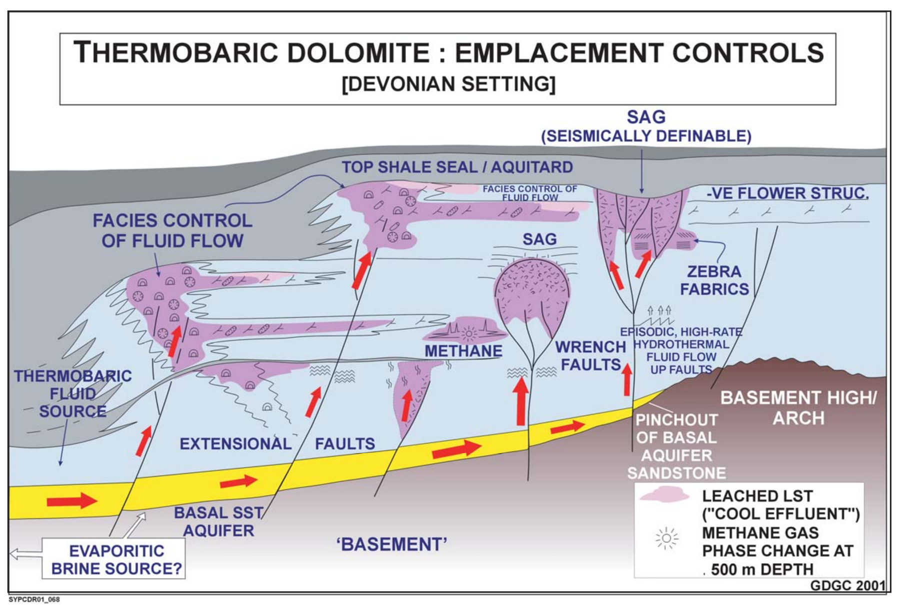
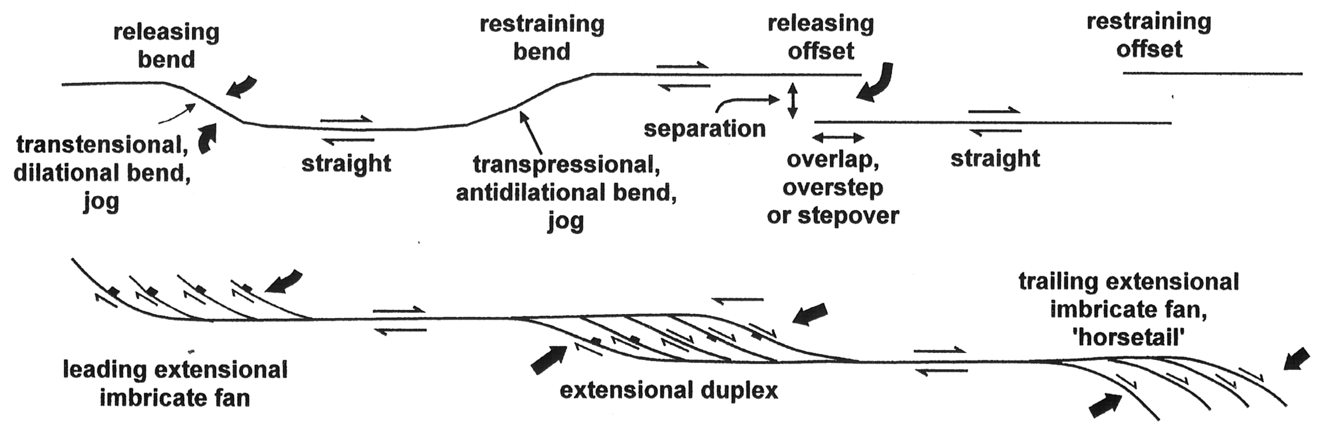
Structural Settings for Hydrothermal Alteration



Hydrothermally altered carbonate reservoirs share much in common with carbonate-hosted MVT ore deposits and SEDEX deposits - they are all fault-controlled - timing of emplacement can in some cases be tied to SEDEX deposits

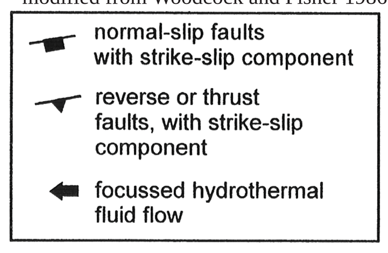


Structural settings for hydrothermal alteration - fault-controlled margins and intraplatform wrench faults are most common sites

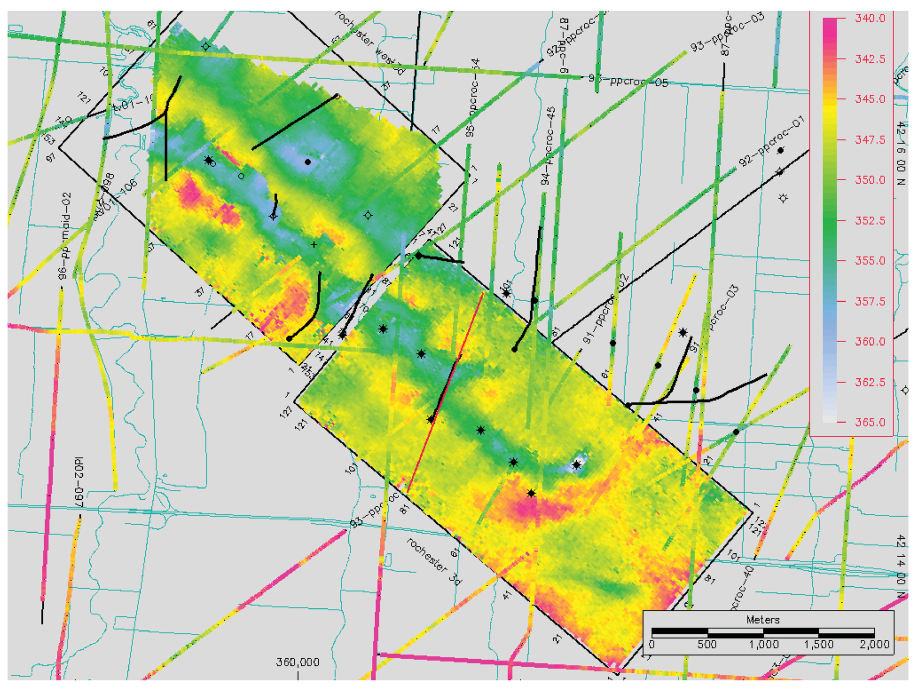


Fault-related hydrothermal fluid flow is most likely to occur in transtensional segments of strike-slip fault zones (block arrows). Even in overall extensional settings, upward fluid flow is most likely to occur where there is a component of strike-slip that opens a conduit to greater depth.

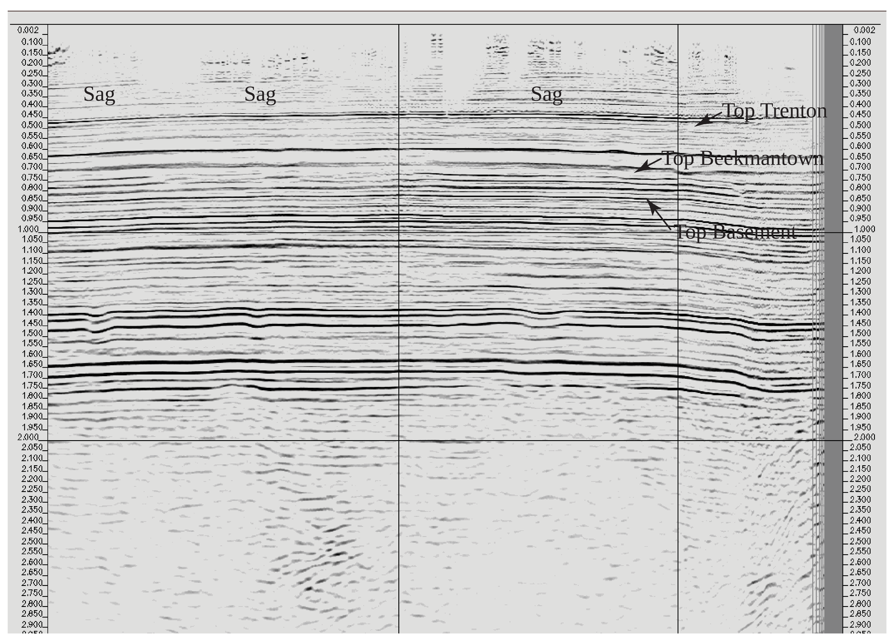
modified from Woodcock and Fisher 1986



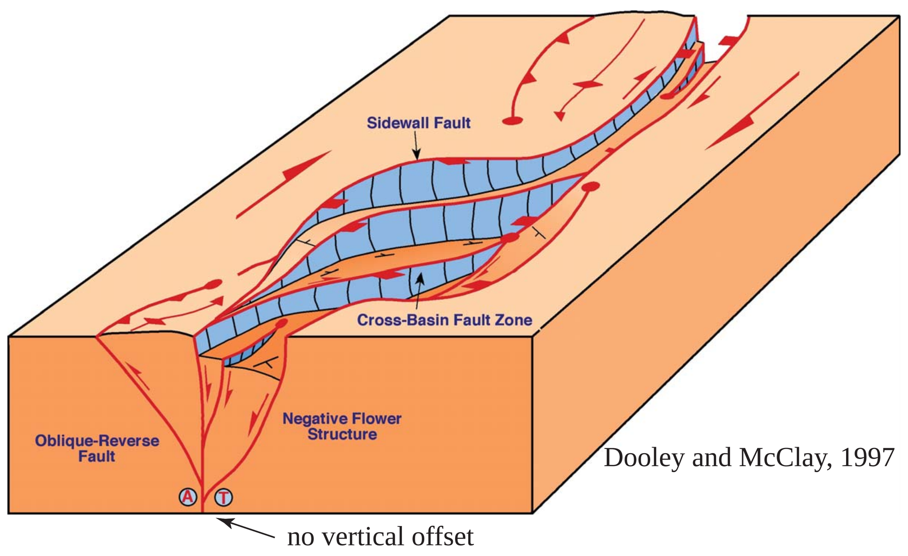
Intra-Platform Wrench Faults



Time-structure map of the top Trenton Formation at Rochester Field in Ontario - note location of oil wells in en echelon sags - it is here that hydrothermal dolomite and hydrocarbons are found (courtesy of Talisman Energy)

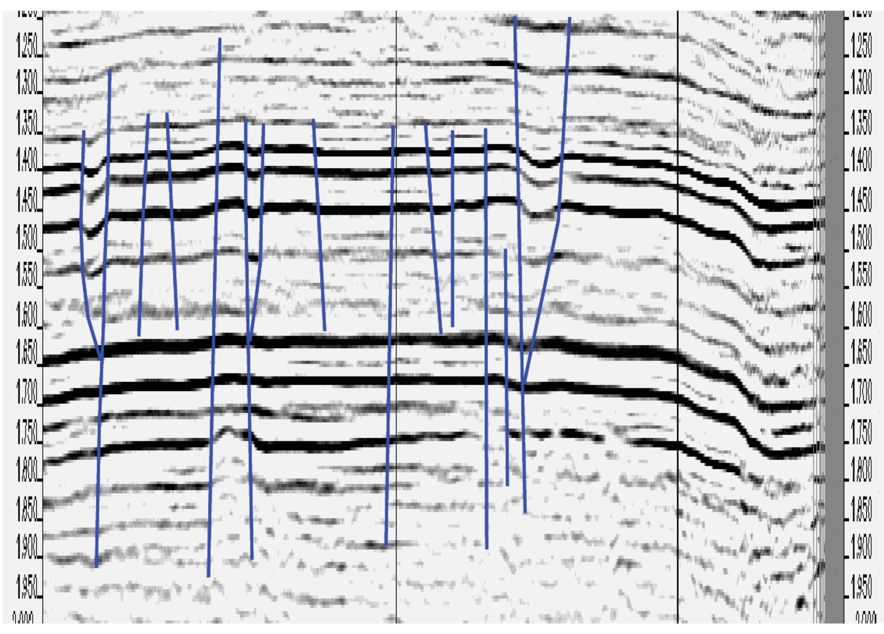


Seismic line from south-central New York showing three sags that have been drilled and produced gas from hydrothermal dolomite in Black River - These very subtle features are interpreted to be negative flower structures (courtesy of Fortuna Energy)

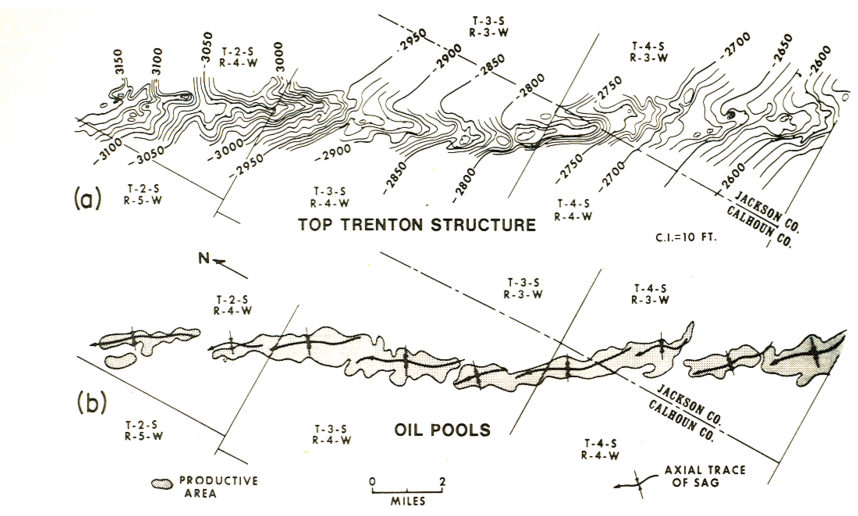


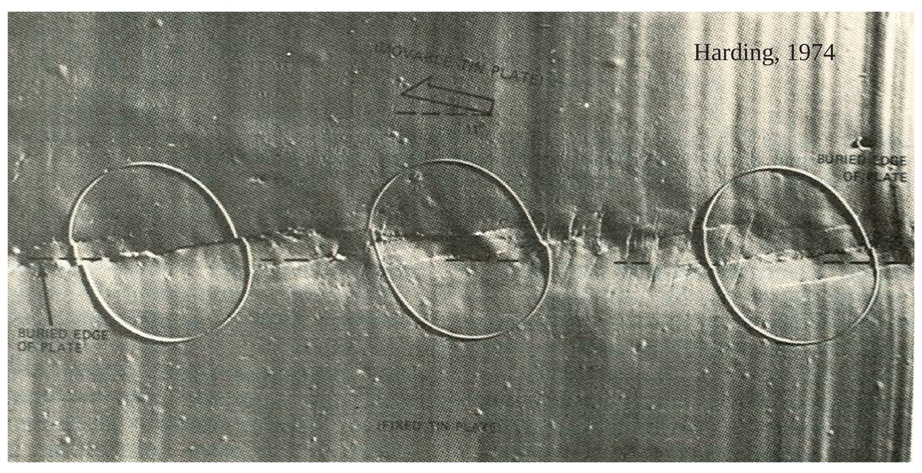
Dooley and McClay, 1997

Block model of "pull-apart" basin shows how sags can be produced by strike slip faulting alone - in cross section view note that there is significant vertical offset at one level, little or no vertical offset below that



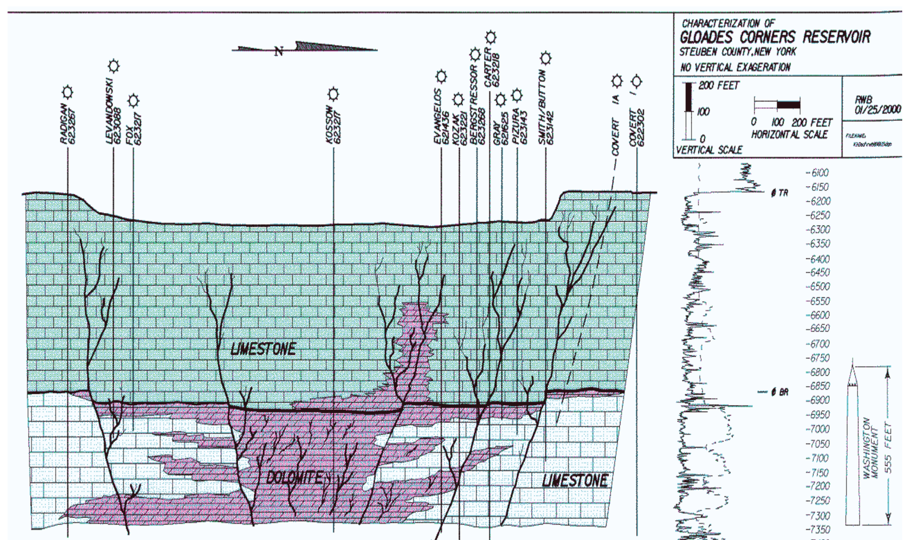
If the above line is stretched, basement control becomes more obvious





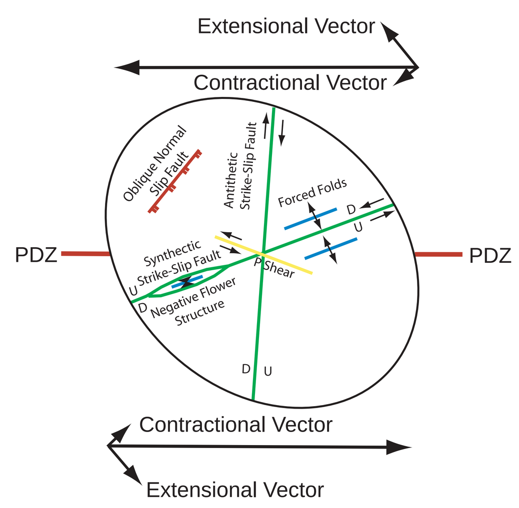
Harding, 1974

Harding (1974) modeled en echelon sags found in Albion Scipio Field (top) and found that they could only be produced by adding a component of extension to dominat left-lateral strike-slip motion



Each of the above sags has dolomite arround the faults (particularly on downthrown side) and limestone away from faults (figure from Columbia Natural Resources)

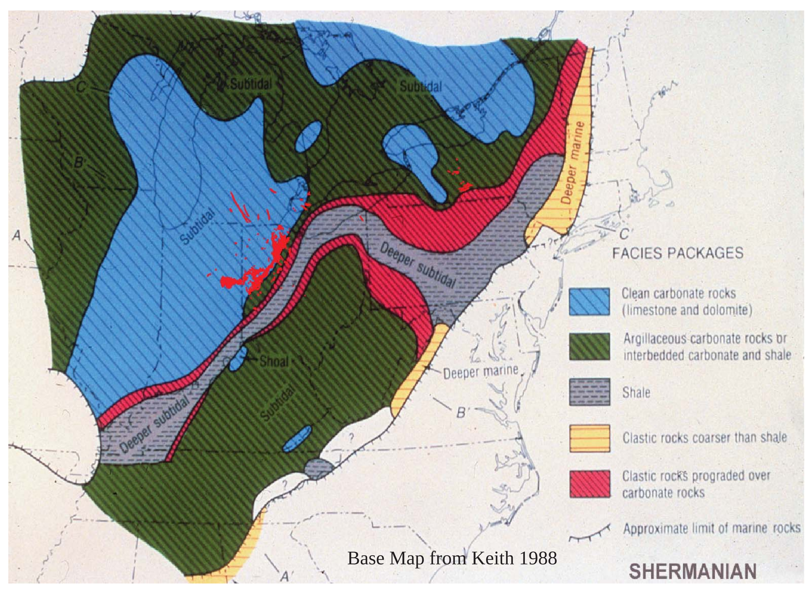
The sags form over synthetic shear faults (Reidel shear) in incipient transtensional fault systems. In more mature strike-slip fault systems, the synthetic shears eventually connect up to make a single zone.



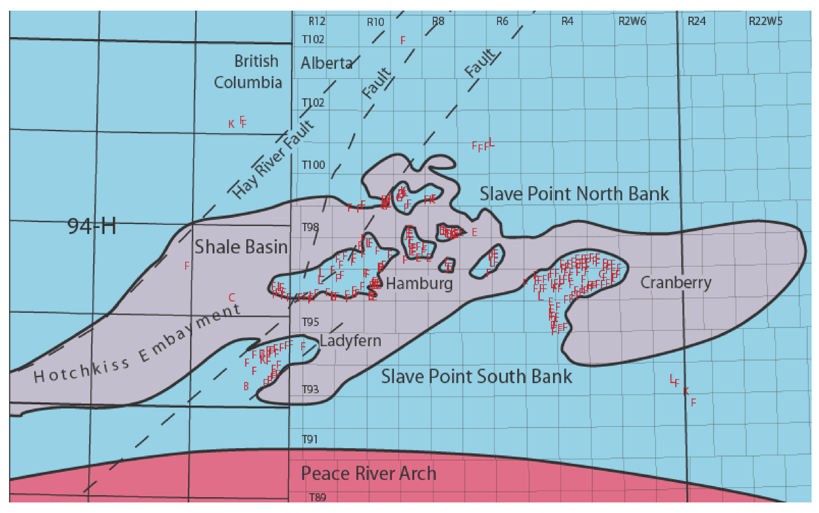
Outcrop Analog

Outcrop Analog for TBR fields has dolomite, breccia, porosity and other features formed along an incipient right-lateral strike-slip fault with an extensional component (See Poster Booth 46)

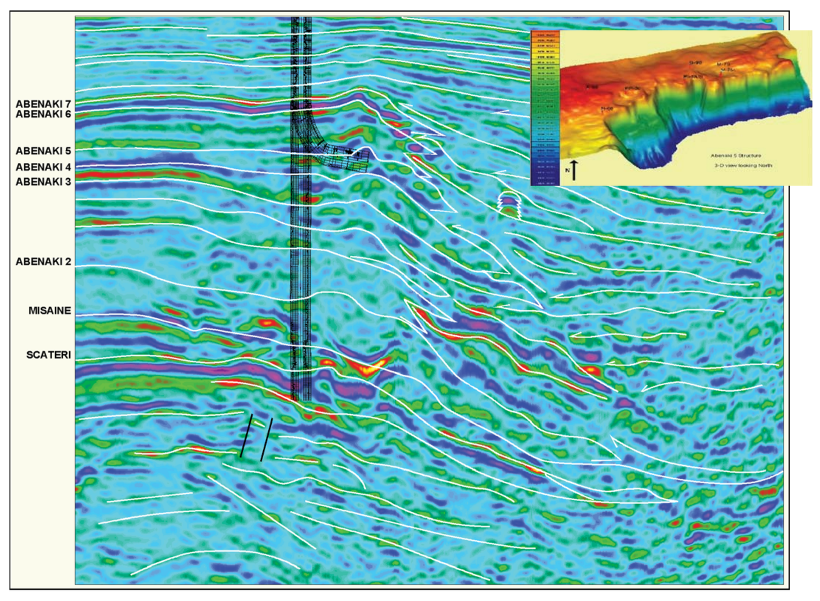
Margin-Bounding Faults



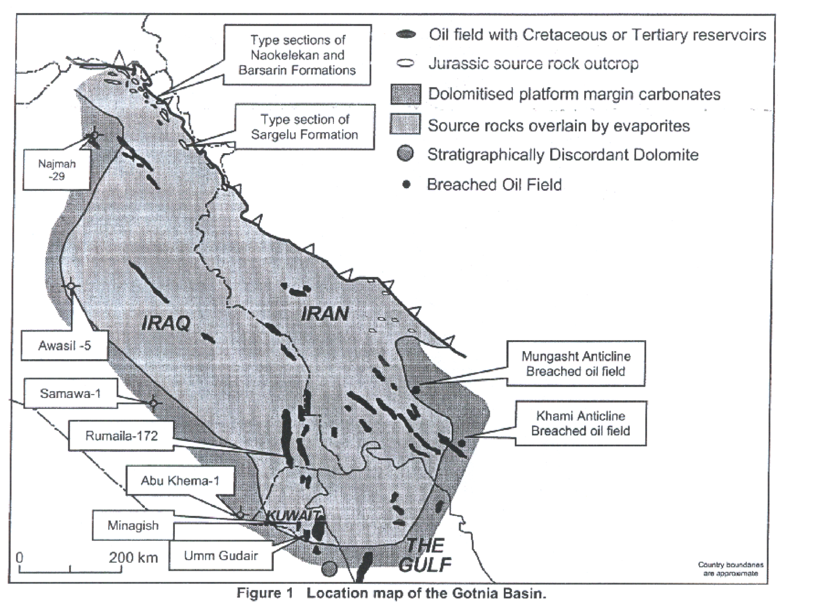
Many Trenton Black River Fields of E. North America (red) line up along margin-bounding faults active during Trenton time. Intersections with intraplatform faults best.



Ladyfern and several other Slave Point Fields occur where faults intersect fault-controlled margin active during Slave Point time

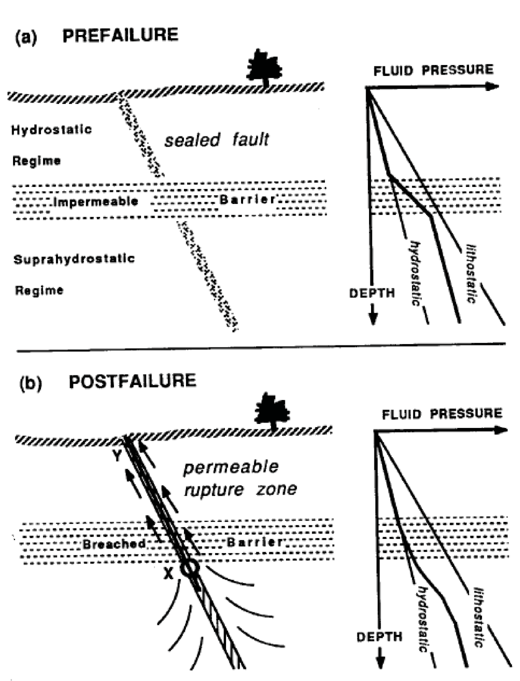


Seismic line over faulted hydrothermally altered Jurassic Abenaki margin, offshore Nova Scotia (from Encana)



Margin of Gotnia Salt Basin was active in Late Mesozoic and has very common hydrothermal alteration in Upper Jurassic and Lower Cretaceous strata (from Goff, 2006).

High Fluid Flow Rates -Up to Meters/Second



Fluid Flow Rates: Fluid flow rates in fault zones have been calculated to be as high as 6 m/s (Eichhubl and Boles, 2000)- The picture above shows cross bedding in internal sediment that is composed of a slurry of saddle dolomite crystals

Fluid Flow Rates: cross-bedding suggests flow rates near 1 m/s - compare this to calculated flow rates for other subsurface fluids which are thought to be on the order of 1 m/yr