Geophysical Research Abstracts,
Vol. 10, EGU2008-A-04523, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-04523
EGU General Assembly 2008

Horsetail fault arrays at strike-slip fault tips in Victoria Land (Antarctica) from the outcrop to the plate scale: fault hierarchy evolution and implications for petroleum exploration

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Development of horsetail splay structures is a well known efficient mechanism to dissipate displacement at the tip of strike-slip faults by transforming horizontal motions into dip-slip motions. The northeastern edge of the Antarctic plate is characterized by an impressive array of intraplate strike-slip deformation belts that originate at the mid oceanic ridge in the Southern Ocean and terminate by transtensional horsetail splaying in the Ross Sea, within the Antarctic plate. Development of this strike-slip deformation belt array in Cenozoic times was facilitated by exploiting the complex tectonic architecture inherited from Early Paleozoic orogenic deformations and from subsequent Mesozoic wide rifting in the Ross Sea. The evolution of the Cenozoic lithospheric scale horsetail transtensional structure progressed through (1) the right-lateral strike-slip reactivation of NW-SE striking, Early Cambrian contractional shear zones, from the Southern Ocean shoulder to the Ross Sea, where they were abutted by the N-S striking Mesozoic extensional basin boundary fault systems; (2) the kinematic linkage between NW-SE right-lateral strike-slip and N-S extensional fault systems at their tips, with reactivation of the latter and creation of deep and elongated displacement accommodation basins; (3) the transfer of residual strike-slip displacement at the fault system tips to the displacement accommodation basin boundary fault systems, which were reactivated as right-lateral strike-slip shear zones characterized by transtensional and transpressional segments, and positive flower structures. Horsetail transtensional structures also developed at the tip of smaller scale right-lateral strike-

slip fault zones splaying off from master strike-slip fault systems. This phenomenon occurred at different scales up to the outcrop scale, in a hierarchical fashion, attesting for its kinematic efficiency for dissipating strike-slip fault displacement. Development of horsetail transtensional structures at the lithospheric scale, like the one described above, provides a very promising petroleum play because it first involves creation of deep troughs suitable to favour sedimentation of source, reservoir, and seal rocks, and then formation of strike-slip-related positive inversion structures that can provide effective traps for petroleum accumulation. Horsetail structures at the smaller scale favour the storage capability of the reservoir rocks by significantly increasing secondary porosity and permeability.