AAPG Datapages/Search and Discovery Article #90310 ©2017 AAPG/SEG International Conference and Exhibition, London, England, October 15-18, 2017

Modeling of Fault and Fold Systems in 3-Dimensions: Insights Into Fault/Fold Initiation, Growth and Linkages

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ABSTRACT

Scaled physical models of extensional and thrust faults provide key insights into the 4D evolution of these systems. 3D reconstruction workflows have been developed so that the results of the analogue models can be interpreted in industry standard seismic interpretation software. This has the advantage of being able to directly compare the physical models with real seismic data, analysing both datasets with the same interpretation workflows. Digitally reconstructed physical models can be combined with digital image correlation (DIC) results that monitor the detailed evolution of the experiments leading to 4D evolutionary reconstructions. A series of extensional models show the clear development of faults through the phases of initiation, growth and linkage resulting in fault architectures comparable to those observed in systems such as the Northern Carnarvon Basin, NW Shelf of Australia. DIC analysis highlights the linkage of major faults via breaching of relay ramps as well as the focused stress across accommodation zones in these segmented fault systems. Similarly the analyses of 2D and 3D analogue models of thrust systems show comparable geometries to those observed in sub-surface seismic datasest such as the Nankai Trough, offshore Japan as well as those observed from field and remotely sensed data such as the Andean and Makran fold and thrust belts. Remotely sensed satellite data and 3D outcrop models generated from drone photographic imagery can also be incorporated into these global workflows for fault and fold analyses. Combining and comparing real seismic with scaled physical models and digital outcrop data enables critical evaluation of the timings and mechanisms of fault and fold system evolution leading to robust analogues for the interpretation of sub-surface data.