Geophysical Research Abstracts
Vol. 19, EGU2017-8553-1, 2017
EGU General Assembly 2017

Geometry and kinematics of accretionary wedge faults inherited from the structure and rheology of the incoming sedimentary section; insights from 3D seismic reflection data

Rebecca Bell (1), Haydn Orme (1), Kathryn Lenette (1), Christopher Jackson (1), Peter Fitch (1), Thomas Phillips (1), and Gregory Moore (2)

(1) Imperial College London, United Kingdom (rebecca.bell@imperial.ac.uk), (2) Department of Geology and Geophysics, University of Hawaii, Honolulu, USA

Intra-wedge thrust faults represent important conduits for fluid flow in accretionary prisms, modulating pore fluid pressure, effective stress and, ultimately, the seismic hazard potential of convergent plate boundaries. Despite its importance, we know surprisingly little regarding the 3D geometry and kinematics of thrust networks in accretionary prisms, largely due to a lack of 3D seismic reflection data providing high-resolution, 3D images. To address this we here present observations from two subduction zones, the Nankai and Lesser Antilles margins, where 3D seismic and borehole data allow us to constrain the geometry and kinematics of intra-wedge fault networks and to thus shed light on the mechanisms responsible for their structural style variability.

At the Muroto transect, Nankai margin we find that the style of protothrust zone deformation varies markedly along-strike over distances of only a few km. Using structural restoration and quantitative fault analysis, we reveal that in the northern part of the study area deformation occurred by buckle folding followed by faulting. Further south, intra-wedge faults nucleate above the décollement and propagate radially with no folding, resulting in variable connectivity between faults and the décollement. The seismic facies character of sediments immediately above the décollement varies along strike, with borehole data revealing that, in the north, where buckle folding dominates un-cemented Lower Shikoku Basin sediments overlie the décollement. In contrast, further south, Opal CT-cemented, and thus rigid Upper Shikoku Basin sediments overlie the décollement. We suggest these along-strike variations in diagenesis and thus rheology control the observed structural style variability.

Near Barbados, at the Lesser Antilles margin, rough subducting plate relief is blanketed by up to 700 m of sediment. 3D seismic data reveal that basement relief is defined by linear normal fault blocks and volcanic ridges, and sub-circular seamounts. The youngest, most basinward thrusts in the wedge strike NW-SE; however, 17 km landward, towards the wedge core, they strike NE-SW. The orientation of the more landward faults correlates with the trend of linear basement relief, whereas thrust fault orientations close to the deformation front are perpendicular to the convergence direction. We notice that oceanic crust that has been subducted is characterised by NE-SW striking, now-inverted normal faults, with some faults extending up through the entire sedimentary section. We suggest that the NE-SW orientation of thrust faults has been inherited from linear basement ridges. In contrast, basement currently subducting beneath the deformation front is dominated by seamounts and is devoid of more linear features. Here, there are no pre-existing normal faults available for reactivation and thrust faults develop perpendicular to the convergence direction.

We show that the incoming plate properties have a profound effect on the geometry of accretionary wedges; it would be difficult to elucidate this without 3D seismic data. Our insights provide new hypotheses that can be tested with numerical and laboratory models.