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Welding kinematics in contractional scenarios: Analog modeling of squeezed preexisting salt diapirs

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Salt is typically mechanically weaker than surrounding rocks under any type of stress. In fold and thrust belts, preexisting salt structures, such as stocks or salt walls, preferentially deform during early contraction and exerts a strong control on structural style and kinematics (e.g. Zagros, Pyrenees, Atlas Mountains, etc.). During contraction, diapirs are squeezed, developing secondary welds that often evolve to thrust welds with higher levels of deformation. There are however remaining questions regarding such process: (1) how such deformation takes place? (2) What are the factors that control the development of thrust welds? (3) What are the styles of associated intra-salt deformation?

In order to address these questions, we used eleven scaled analog models to examine the kinematics of squeezed salt diapirs during contraction, focusing on secondary welding processes, related structures, timing, and the influence of preexisting salt structures in the evolution of thrust wedges. The experimental program involved a mechanically ductile-brittle thrust wedge where two pre-built salt diapirs, located at different distances from the mobile backstop, were subjected to shortening. Diapirs included different colored passive markers to track internal salt deformation. The setup was designed to test parameters such as the shape (from vertical stocks to tilted walls), roof thickness of diapirs, the presence/absence of remnant salt in the source layer, and the role of diapir pedestals.

Our results show that during contraction, salt related deformation involving squeezing, roof arching, crestal extension and finally extrusion predates the development of thrust wedge. These sequence of events occur earlier on larger diapirs having well-developed pedestal especially when they are located closer to the deformation front (i.e. the mobile backstop). Although both diapirs display similar deformation patterns, the activity of the more distal diapir is discontinuous and dependent upon the processes occurring on the diapirs closer to the backstop such as development of brittle structures and/or secondary welding. Thrusts and backthrusts have curved traces with lateral ramps merging into the diapirs, thereby defining reentrants and indentors. These indentors squeeze the diapiric stems until secondary welding occurs, isolating pear-shaped diapirs from their deeper pedestals. Depending on the original shape of the preexisting diapirs (finger-shaped stock, vertical or tilted salt wall, and with or without pedestal), different final geometries develop (vertical secondary welds, thrust welds and diapirs decapitated by thrusts). Finally, roof thickness does not significantly affect the timing but does influence the shape of the arched roof, the crestal graben and the salt fountain: the thinner the cover is, the more elongated they are.