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Salt supply to and significance of asymmetric salt diapirs

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Salt diapirs can be asymmetric both internally and externally reflecting their evolution history. As such, this asymmetry bear a significant amount of information about the differential loading (± lateral forces) and in turn the salt supply that have shaped the diapir. In two dimensions, In this study we compare results of analogue and numerical models of diapirs with two natural salt diapris (Klodawa and Gorleben diapirs) to explain their salt supply and asymmetric evolution. In a NW-SE section, the Gorleben salt diapir possesses an asymmetric external geometry represented by a large southeastern overhang due to salt extrusion during Middle Cretaceous followed by its burial in Tertiary. This external asymmetry is also reflected in the internal configuration of the diapir which shows different rates of salt flow on the two halves of the structure. The asymmetric external and internal geometry of the Gorleben diapir reflect an asymmetric salt supply driven by an asymmetric differential loading. The Kłodawa Salt Structure of Poland is also an asymmetric salt structure driven by asymmetric differential loading from the overlying sediments. The KSS is a salt ridge built of Zechstein evaporite series located in the axial part of the former Mid-Polish Trough. This extensional basin was filled with Zechstein to Cretaceous sediments and was inverted in the Late Cretaceous to Paleogene time. The diapir was triggered in Triassic above a basement fault. In late Triassic, after intruding cover sediments, the diapir extruded an overhang. Using the asymmetric Kłodawa Salt Structure (KSS) in central Poland as a prototype, a series of analogue models were carried out to investigate the evolution history and salt supply driven by asymmetric differential loading. During extension of the model, a daipir was upbuilt by the sand cover above the basement fault. The ductile layer was allowed to extrude a wide overhang at the model “late Triassic” time. The diapir was later downbuilt with progressive extension. At the end of the extension, a part of the model was sectioned for photographing, whereas the remaining part was inverted resulting in uplift of the hanging wall portion of the model. The model was eventually buried and sectioned for photographing.

The experiments showed that at an early extensional stage, the diapir was primarily fed from the footwall side. Footwall material constitutes the uppermost portion of the structure and the dominant component of the overhang. Taking the top of the prekinematic layer as a reference line, footwall material made up between >90% at the initial stage of the diapir to about 75% in the mature diapir (Fig. 1a). Reverse movement on the basement fault resulted in an increase in the diapir height, overall thinning of its stem and larger supply of the ductile layer from the hanging-wall side into the diapir. After the inversion, the hanging-wall material constituted 35-45% of the structure and it was dominantly located in the diapir stem. Model results show that asymmetric diapir reflect a differential salt supply which is driven by an asymmetric sedimentation and hence differential loading on either side of a salt diapir.