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Fault activity and diapirism in the Mississippian to Late Cretaceous Sverdrup Basin: New insights into the tectonic evolution of the Canadian Arctic

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The geological evolution of the Arctic Ocean is enigmatic due to uncertainties surrounding key tectonic events. One of these uncertainties is the timing and nature of the rifting event that led to the opening of the Amerasia Basin, one of the two major basins into which the Arctic Ocean is divided (the other one being the Eurasian Basin). The initiation of the Amerasia Basin is attributed to different ages: Rhaetian, Hettangian or Bajocian. These ages have been interpreted from first order stratigraphic unconformities identified in adjacent sedimentary basins (exposed in Arctic Alaska and Canada) or from geophysical data from the adjacent continental margins (Arctic Alaska, Arctic Canada and Chukchi Borderland). However, due to its location in a polar region, data are scarce and the existing models of tectonic evolution are controversial.

This paper focuses on the Sverdrup Basin, which flanks the Amerasia Basin along the north-east Canadian Arctic. The Sverdrup Basin exposes up to 13 km of Mississippian to Late Cretaceous marine to continental sediments. The structure at the basin centre is characterised by a belt of salt diapirs, sourced from Carboniferous salt, associated at times with south-easterly directed thrusts. At the basin's margins, salt diapirs are absent and the structure is dominated by westerly and south-easterly directed thrusts (involving different amounts of strike-slip). Thrusts developed during the latest Cretaceous to Palaeogene Eurekan Orogeny by the reactivation of previous structures from both the Proterozoic to Mississippian Ellesmerian Orogen and the Carboniferous to Late Cretaceous Sverdrup Basin. As a result, direct observations of potential faults related to the Sverdrup Basin development are difficult, if not impossible, to make and there is significant uncertainty regarding the key tectonic events that controlled the formation of the basin. The prevailing view is that the basin initiated by early Carboniferous to early Permian rifting, with a second rift event occurring during the Late Jurassic to the Early Cretaceous. Accordingly, the basin was tectonically quiescent during most of the Mesozoic. This fails to explain the creation of accommodation space for 13 km of sediments, particularly during the Triassic, which in places comprises up to 4 km of strata.

This communication presents a series of restored structural cross-sections across the Sverdrup Basin. Cross-sections are based on published sources and dip data extracted from a Digital Elevation Model overlain with Landsat Images. The main goal of the restorations is to remove the deformation associated with the Eurekan Orogeny in order to identify the original structural framework of the Sverdrup Basin. Structural restoration reveals that, during the Mesozoic, the Sverdrup Basin centre was dominated by the rising of salt diapirs (presently squeezed) while the basin's margins were dominated by newly-identified Triassic to Jurassic extensional fault development (presently inverted as thrusts). The discovery of Triassic fault activity in the Sverdrup Basin is a new finding and forms an extra element to be considered in tectonic models for the proto-Amerasia Basin and the wider Arctic region.