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Multi-phase Structural Inversion in the Chukchi Shelf, Alaska

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Interpretation of over 100,000 line-km of reprocessed 2D, time-migrated, seismic-reflection data from U.S. Chukchi shelf documents at least 3 distinctly different, crustal-scale negative and positive inversion events in the last 400 Ma. A well stratified basement whose internal geometry clearly defines a pre-Carboniferous, thin-skinned fold-and-thrust belt, represents the earliest recognizable tectonism in the area. One that accommodated west-east (present coordinates) shortening likely related to docking of the Pearya terrane with Laurentia. The first inversion event, and dominant crustal feature in the Chukchi Shelf, is the Hanna Trough, a north-south failed rift that accommodated more than 10 km of Carboniferous–Jurassic syn-rift and post-rift (sag) strata, buried beneath >2 km of Cretaceous and Cenozoic foreland deposits. Carboniferous extensional collapse of the previous orogenic belt to form the Hanna Trough was influenced heterogeneously by the pre-Carboniferous contractional fabrics. Many rift-phase normal faults detach along pre-Carboniferous thrust faults in negative inversion, creating locally steepening bends in normal faults that form distinctive synthetic growth strata. Other faults cut across basement stratigraphy showing more typical rollover geometries to growth strata, and dissection of contractional structures in the pre-rift strata with no specific negative inversion.

After a period of Triassic and early Jurassic subsidence, in the south-central Chukchi shelf several north-south rift-phase normal faults were inverted in a second event in the Late Jurassic, forming local, classical, asymmetric positive inversion structures due to west-east shortening likely associated with the Chukotkan orogeny. In the central shelf are other inverted highs of older rifts, of somewhat younger age, likely Late Cretaceous to early Paleogene that also indicate west-east contraction. Several highs of a similar age are also present in the northern Arctic Platform, but with a different vergence. Here clear east-west striking, deep, crustal-involved thrusts contribute to north-south contraction; these resulted in uplift of the pre-Carboniferous section to the seafloor in places. These Cretaceous contractional structures are obscured by renewed Cenozoic east-west extension, which reactivated older rift structures once again during a third (negative) inversion. We show that the documenting of multi-phase inversion in the Chukchi Shelf is vital to unraveling the tectonic history of the area.