Structure of Hanna Trough and Facies of Ellesmerian Rocks, U.S. Chukchi Shelf, Alaska

STRUCTURE OF HANNA TROUGH AND FACIES OF ELLESMERIAN SEQUENCE, U.S. CHUKCHI SHELF, ALASKA

KEY POINTS

1. Magnetic and gravity data suggest a northerly structural fabric within pre-Late Devonian basement beneath Hanna trough.

2. Hanna trough rifting developed as swarms of half-grabens along northerly faults probably templated on basement fabric.

3. On the south, Hanna trough merges with the east-trending faults of the contemporaneous Arctic Alaska basin. On the north, Hanna trough is segmented by a trans-rift "accommodation zone", across which the northern segment is offset at least 100 km west of the axis of the southern segment.

4. The fault-driven rift phase of subsidence occurred from Devonian(?) to Late Permian time and is recorded by the Lower Ellesmerian sequence, which reaches maximum thicknesses of 36,000 feet in deep basins south of the accommodation zone.

5. Thermal subsidence or "sagging" occurred from Late Permian to Late Jurassic time and is recorded by the Upper Ellesmerian sequence, which reaches maximum thicknesses of 12,000 feet in southern parts of Hanna trough.

6. Facies maps based on well data indicate that uplifted areas both east and west of Hanna trough contributed clastic debris to Hanna trough from Mississippian (and earlier?) time through Permo-Triassic time. The uplifts to the west on Chukchi platform apparently became subdued (as sediment sources) after Permo-Triassic time.

7. North-trending magnetic and gravity anomalies on Chukchi platform are interpreted by Herman and Zerwick (1994) as possibly marking a magmatic complex (arc terrane?) amalgamated within basement. Plutonic and volcanic detritus is prominent in Mississippian, Pennsylvanian, and Permian (less so) rocks in western Hanna trough, and, was presumably derived from the hypothesized magmatic complex within basement to the west.

8. In eastern Hanna trough, facies transitions from margin to paleogeographic deep mimic the familiar transitions in time-equivalent strata from north (margin) to south (deep basin) in the Arctic Alaska basin.

STRUCTURE OF HANNA TROUGH AND FACIES OF ELLESMERIAN SEQUENCE , U.S. CHUKCHI SHELF, ALASKA

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Hanna trough is a rift basin of probable Devonian to Late Jurassic age that trends north beneath the U.S. Chukchi shelf offshore northwestern Alaska. The basin formed a depocenter for the accumulation of over 38,000 feet (11,600 m) of strata of the Ellesmerian sequence and is a westward extension of the petroleum-rich Arctic Alaska basin that underlies the Alaska North Slope. Hanna trough overlies a seismic basement that appears to consist of Devonian and older terranes that were assembled into a crustal unit with a northerly structural grain in pre-Middle or Late Devonian time. A magnetic high may mark a magmatic arc within basement that apparently contributed granitic sedimentary debris found within Mississippian and Pennsylvanian calcareous sandstones beneath Chukchi shelf.

Hanna trough rift structures also developed along northerly lines that mimic the northerly grain of basement. The fundamental structural units of Paleozoic rifting, and the sites of earliest sedimentation, are half-grabens that pervasively floor Hanna trough. The half-grabens are floored by wedge-shaped bodies of strata that are correlated by seismic inference to the Endicott Group (Upper Devonian to Mississippian). Fault-driven subsidence occurred mostly from Devonian (inferred) to Permian time and controlled deposition of over 36,000 feet (11,000 m) of strata of the Lower Ellesmerian sequence. From Late Permian to Late Jurassic time, a sag phase of subsidence controlled the deposition of up to 12,000 feet (3,660 m) of strata of the Upper Ellesmerian sequence in Hanna trough.

The oldest rocks penetrated by wells on Chukchi shelf are Upper Mississippian rocks equivalent to the Lisburne Group. The lithofacies and petrology of clastic rocks suggest the existence of highland sediment sources both east and west of Hanna trough for Mississippian through Permian sequences. The western highland (Chukchi platform) was subdued or absent by the time of deposition of the mostly basinal rocks of Triassic and younger ages in western Hanna trough. The eastern highland sediment source (Arctic platform) remained active through Late Jurassic time. Within the Upper Ellesmerian sequence (Late Permian to Late Jurassic), facies transitions from the east margin to paleogeographic deeps in Hanna trough mimic the well-documented and familiar facies transitions in time-equivalent strata from north (margin) to south (deep basin) in the Arctic Alaska basin.

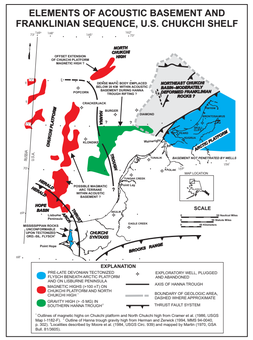
Additional Information: Sherwood, K.W., Johnson, P.P., Craig, J.D., Zerwick, S.A., Lothamer, R.T., Thurston, D.K., and Hurlbert, S.B., 2002, Structure and stratigraphy of the Hanna Trough, U.S. Chukchi Shelf: in Miller, E.L., Grantz, A., and Klemperer, S.L. (eds.), Tectonic Evolution of the Bering Shelf-Chukchi Sea-Arctic Margin and Adjacent Landmasses: Boulder, Colorado, Geological Society of America Special Paper 360, p. 39-66.

Presented at Joint Conference of Geological Society of America (Cordilleran Section), American Association of Petroleum Geologists (Pacific Section), and Society of Petroleum Engineers (Western Region), *North to Alaska: Geoscience, Technology and Natural Resources*, 08-10 May 2006, Anchorage, Alaska.

Reference: Sherwood, K.W., 2006, Structure of Hanna Trough and Facies of Ellesmerian Sequence, U.S. Chukchi Shelf, Alaska (Abstract with 2 Posters.): *2006 Joint Meeting of Cordilleran Section, Geological Society of America (GSA), Pacific Section, American Association of Petroleum Geologists (AAPG), and Alaska/Western Section of Society of Petroleum Engineers (SPE), 08-10 May, Anchorage, Alaska,* Geological Society of America Abstracts, Volume 38, No. 5, abstract 37-2, p. 85. Updated with higher-resolution facies maps on 24 May '07.

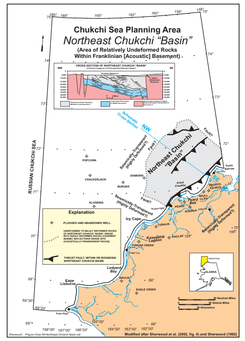
CHUKCHI SHELF BASEMENT ELEMENTS AND ENDICOTT BASINS OF ARCTIC ALASKA

ELEMENTS OF ACOUSTIC BASEMENT AND FRANKLINIAN SEQUENCE, U.S. CHUKCHI SHELF

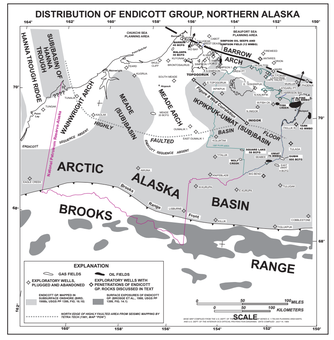


Chukchi Sea Planning Area *Northeast Chukchi "Basin"*

(Area of Relatively Undeformed Rocks Within Franklinian [Acoustic] Basement)

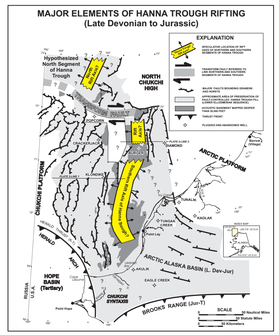


DISTRIBUTION OF ENDICOTT GROUP, NORTHERN ALASKA

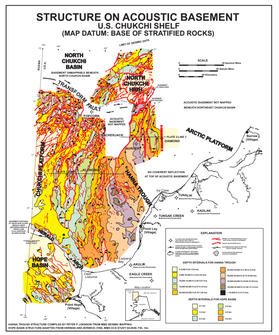


HANNA TROUGH RIFT SYSTEM, BASEMENT STRUCTURE, AND STRATIGRAPHY

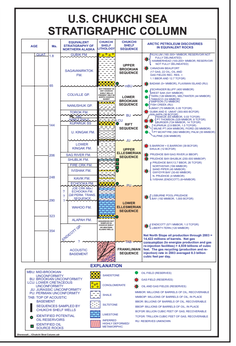
MAJOR ELEMENTS OF HANNA TROUGH RIFTING (Late Devonian to Jurassic)



STRUCTURE ON ACOUSTIC BASEMENT U.S. CHUKCHI SHELF (MAP DATUM: BASE OF STRATIFIED ROCKS)

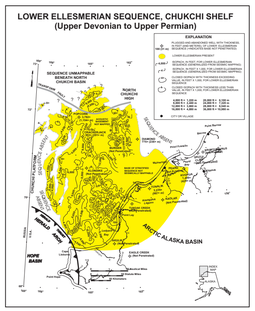


U.S. CHUKCHI SEA STRATIGRAPHIC COLUMN

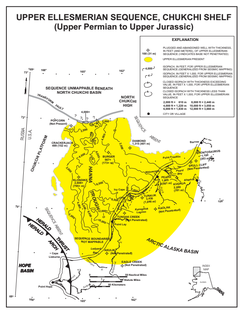


ISOPACH MAPS AND STRATIGRAPHIC PANEL

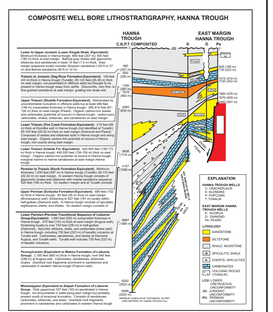
LOWER ELLESMERIAN SEQUENCE, CHUKCHI SHELF (Upper Devonian to Upper Permian)



UPPER ELLESMERIAN SEQUENCE, CHUKCHI SHELF (Upper Permian to Upper Jurassic)

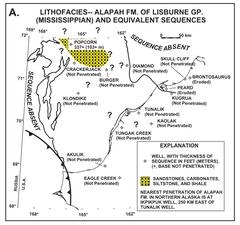


COMPOSITE WELL BORE LITHOSTRATIGRAPHY, HANNA TROUGH

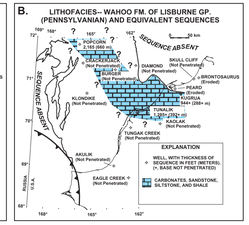


FACIES MAPS

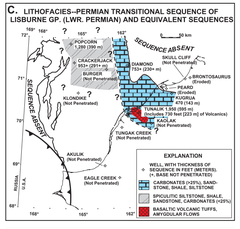
A. LITHOFACIES– ALAPAH FM. OF LISBURNE GP. (MISSISSIPPIAN) AND EQUIVALENT SEQUENCES



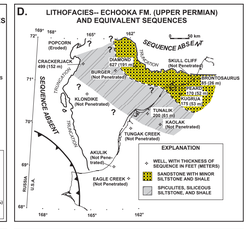
B. LITHOFACIES– WAHOO FM. OF LISBURNE GP. (PENNSYLVANIAN) AND EQUIVALENT SEQUENCES



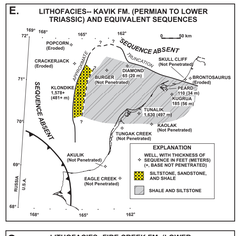
C. LITHOFACIES–PERMIAN TRANSITIONAL SEQUENCE OF LISBURNE GP. (LWR. PERMIAN) AND EQUIVALENT SEQUENCES



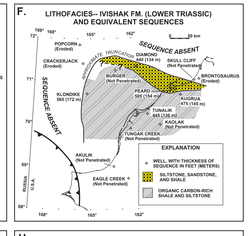
D. LITHOFACIES– ECHOOKA FM. (UPPER PERMIAN) AND EQUIVALENT SEQUENCES



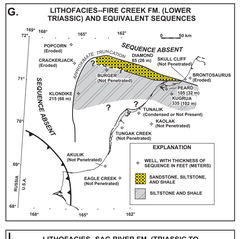
E. LITHOFACIES– KAVIK FM. (PERMIAN TO LOWER TRIASSIC) AND EQUIVALENT SEQUENCES



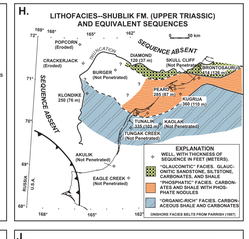
F. LITHOFACIES– IVISHAK FM. (LOWER TRIASSIC) AND EQUIVALENT SEQUENCES



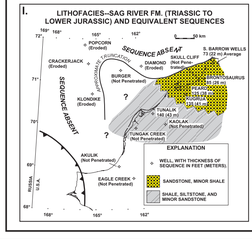
G. LITHOFACIES–FIRE CREEK FM. (LOWER TRIASSIC) AND EQUIVALENT SEQUENCES



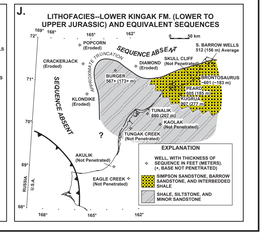
H. LITHOFACIES–SHUBLIK FM. (UPPER TRIASSIC) AND EQUIVALENT SEQUENCES



I. LITHOFACIES–SAG RIVER FM. (TRIASSIC TO LOWER JURASSIC) AND EQUIVALENT SEQUENCES

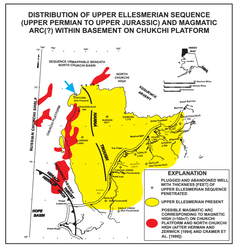


J. LITHOFACIES–LOWER KINGAK FM. (LOWER TO UPPER JURASSIC) AND EQUIVALENT SEQUENCES

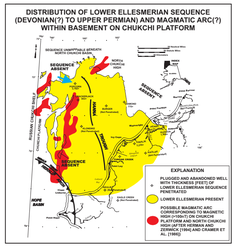


SEDIMENTARY EVIDENCE IN PENNSYLVANIAN AND MISSISSIPPIAN ROCKS, POPCORN WELL, CHUKCHI SHELF, FOR PRE-DEVONIAN MAGMATIC ARC IN BASEMENT BENEATH CHUKCHI PLATFORM

DISTRIBUTION OF UPPER ELLESMERIAN SEQUENCE (UPPER PERMIAN TO UPPER JURASSIC) AND MAGMATIC ARC(?) WITHIN BASEMENT ON CHUKCHI PLATFORM

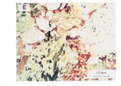


DISTRIBUTION OF LOWER ELLESMERIAN SEQUENCE (DEVONIAN(?) TO UPPER PERMIAN) AND MAGMATIC ARC(?) WITHIN BASEMENT ON CHUKCHI PLATFORM

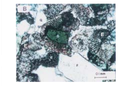


PENNSYLVANIAN ROCKS

9,359 feet: Sandstone with clasts of plutonic rocks (Lp), feldspar (F), quartz (Q), and abundant fragments of echinoderm, brachiopod, and bryozoan fossils.

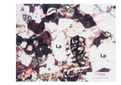


9757 feet. Calcite-cemented sandstone with clasts of gneissic rock (Lm), plutonic rock (Lp), and sandstone (Ls), with abundant fossil fragments

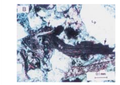


9806 feet. Calcite-cemented sandstone with clasts of feldspar (F), quartz (Q), and glauconite (G), with abundant echinoderm fossil fragments (E)

MISSISSIPPIAN ROCKS



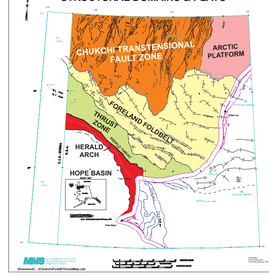
9900 feet. Very coarse-grained sandstone with clasts of volcanic rocks (Lv), plutonic rocks (Lp), feldspar (F), and quartz, with abundant echinoderm fragments (E)



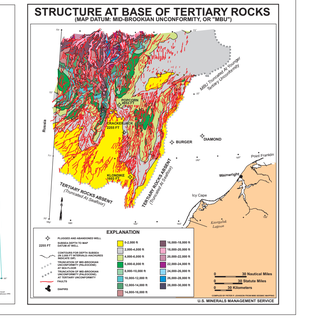
9966 feet. Calcite-cemented sandstone with abundant plutonic rock fragments (Lp), quartz, and fragments of echinoderms and brachiopods (Bp)

TRANSTENSIONAL FAULTS IN BROOKIAN SEQUENCE ARE ROOTED IN REACTIVATED HANNA TROUGH RIFT FAULTS

LOWER BROOKIAN PLAY SEQUENCE STRUCTURAL DOMAINS & PLAYS



STRUCTURE AT BASE OF TERTIARY ROCKS (MAP DATUM: MID-BROOKIAN UNCONFORMITY, OR "MBU")



MMS

Alaska OCS Region
Anchorage, Alaska