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EVOLUTION OF A CARBONIFEROUS INCISED SHELF SEQUENCE- GOLATA FORMATION, WESTERN CANADA.

Study area

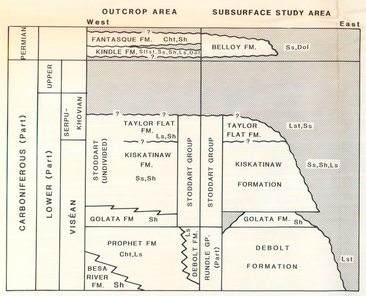


Table of Formations

The Stoddart Group was studied in N.W. Alberta and N.E. British Columbia within the eastern, subsurface portion of the Peace River Embayment. The group comprises 3 formations: Golata, Kiskatinaw and Taylor Flat formations (in ascending order).

Golata shales form the base of a thick, clastic-dominated depositional sequence of interbedded sandstone, shale and limestone of the Stoddart Group, representing a major clastic pulse overlying a thick sequence of Rundle Group platform carbonates. The Golata Fm. can be subdivided into a thin basal transition unit, a thick medial unit of black shale and a thin upper coloured shale unit.

The Basal Transition unit, resting on the Debolt Fm., consists of argillaceous dolomite and argillaceous sandstone and represents the start of a clastic pulse that choked off carbonate production of the Debolt Fm..

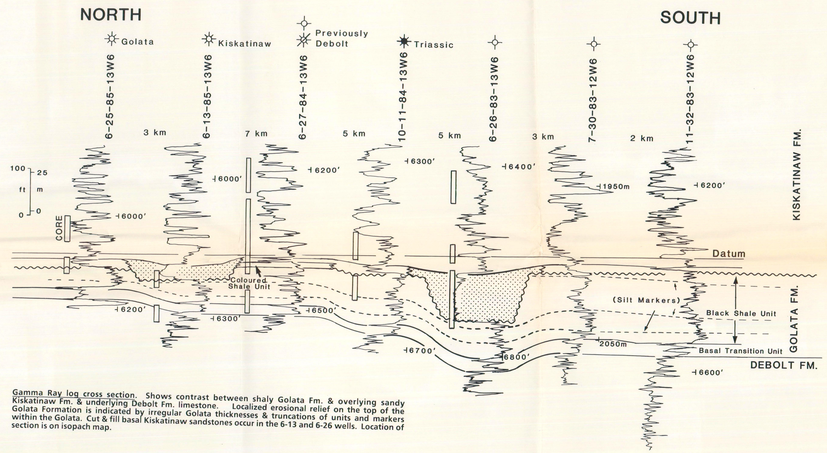
The Black Shale unit is a carbon-rich, black, silty and sandy shale characterized by abundant *Chondrites* and *Planolites* burrows. Deposition occurred on a marine shelf in a low energy, dysaerobic, shallow setting, possibly in a broad protected lagoon or embayment.

The Upper Coloured Shale unit comprises varicoloured shale, wacke, siltstone and fine grained sandstone characterized by structureless, nodular, mottled or banded fabrics. The unit grades downward into the burrowed and laminated Black Shale unit. Carbonaceous debris, root casts, pedogenic slickensides, nodules of anhydrite, hematite, limonite and calcite, and alteration colours indicate extremely shallow to subaerial deposition. This deposition is consistent with floodplain, intertidal or bayfill settings.

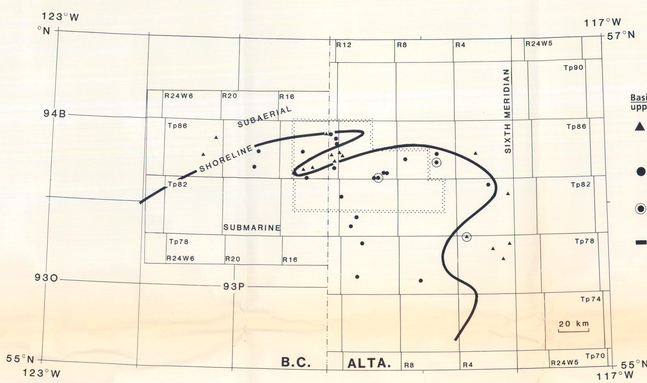
The contact of the Golata with the overlying basal deposits of the Kiskatinaw Fm. displays two habits: 1) thick basal Kiskatinaw channel sands rest on the Golata Black Shale unit (the Coloured Shale unit being absent); or, 2) thin interbedded basal Kiskatinaw sandstones and shales rest on and grade to the Golata Coloured Shale unit. Also, the basal Kiskatinaw units appear to be laterally equivalent to the Golata Coloured Shale unit. Although the Golata/Kiskatinaw contact resembles a disconformity and possible sequence boundary, it represents localized cut and fill deposition of basal Kiskatinaw channels contemporaneous with off channel deposition of thin sands and shales of the basal Kiskatinaw or shales of the Golata Coloured Shale unit.

Structural - stratigraphic petroleum traps are developed where reservoirs of basal Kiskatinaw channel sands are sealed by off channel shales (basal Kiskatinaw and Golata Coloured Shale unit) and also sealed by cross-cutting normal faults related to Peace River Embayment tectonics.

Cores from 12-14-78-1W6, 6-27-84-13W6, 6-26-83-13W6, 7-2-84-6W6 and others display the units and lithologies of the Golata and Kiskatinaw formations. 12-14 and 6-27 (see figure) show examples of gradational Golata/Kiskatinaw contacts whereas 6-26 and 7-2 show erosional contacts.



Gamma Ray log cross section. Shows contrast between shaly Golata Fm. & overlying sandy Kiskatinaw Fm. & underlying Debolt Fm. limestone. Localized erosional relief on the top of the within the Golata. Cut & fill basal Kiskatinaw sandstones occur in the 6-13 and 6-26 wells. Location of section is on isopach map.



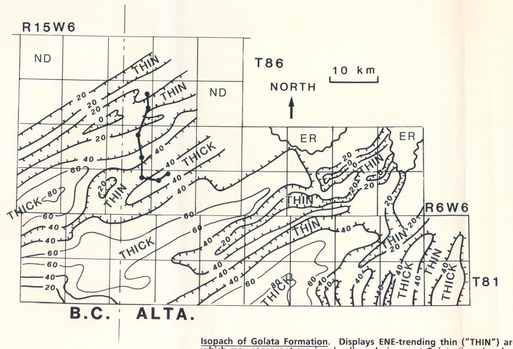
Basinal Setting - Coloured Shale unit time, uppermost Golata Fm.

▲ Cores with Coloured Shale unit, representing varicoloured shale deposition and subaerial exposure of Golata.

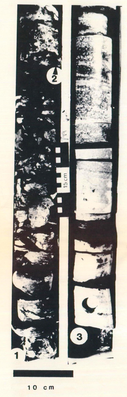
● Cores with eroded Black Shale unit, abruptly overlain by Kiskatinaw Fm., represents submarine exposure.

◉ Cores with clasts of Coloured Shale unit in basal lag of Kiskatinaw sands (see photos).

▬ Shoreline position shown by subaerial/submarine boundary.



Isopach of Golata Formation. Displays ENE-trending thin ("THIN") areas which may represent erosional valleys during post-Golata time, i.e. during basal Kiskatinaw deposition. These valleys localized many of the basal Kiskatinaw channel sands. Thicks are areas that generally lack basal Kiskatinaw sands and thus represent erosional remnants forming basal Kiskatinaw headlands. C.I. = 20 m, ND = No Data, ER = Eroded by later, pre-Permian events. Cross-section in centre.



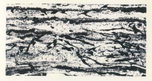
Kiskatinaw Formation - Golata Formation contact. Black Shale unit of Golata Formation (1) abruptly overlain by basal conglomerate lag of Kiskatinaw Formation (2). Lag overlain by crossbedded medium grained quartz sandstone of basal Kiskatinaw reservoir unit (3). (11-34-84-15W6).

Kiskatinaw Formation - Golata Formation contact. Black Shale unit of Golata Formation (1) overlain by basal conglomerate lag of Kiskatinaw Formation (2). Reddish colours of shale clasts and similar appearance to Coloured Shale unit suggest their source was exposed portions of the Golata Formation (i.e. Coloured Shale unit). (7-2-84-6W6).

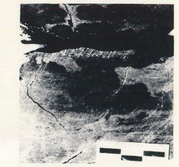
Rhizocretion(?) in shale of Golata Formation Coloured Shale unit. Represents an alteration halo developed around a root. Colours of rhizocretion are red (dark grey centre), green (light grey outer zone) within a matrix of mainly red shale with some green mottling. Remnant *Chondrites*(?) sp. burrows are in shale matrix. (10-30-84-12W6).

Homogeneous wacke lithology developed in Golata Formation Coloured Shale unit. A churned mixture of sand, silt and clay representing a paleosol development. Colour is mottled light green. This lithology grades downward with increasing preservation of burrows to unaltered Black Shale unit (10-30-84-12W6).

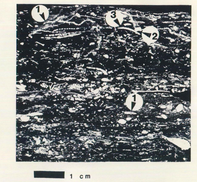
Fine laminations preserved in indurated sandy facies of Black Shale unit. *Chondrites* sp. networks (arrows) and unidentified sub-vertical burrows disrupt the laminations. (10-18-77-1W6).



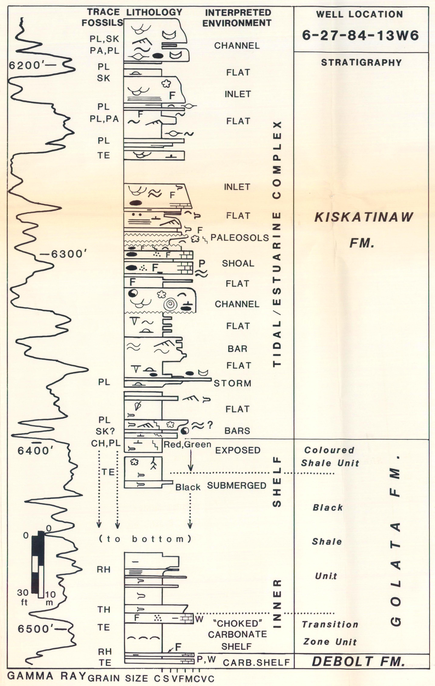
Chondrites sp. network in sandy interbed of Golata Formation Black Shale unit. Burrows are filled with black shale and occur in a host of light grey laminated sand and dark grey shale. (12-14-78-11W6).



Nodular fabric developed in shale of Golata Formation Coloured Shale unit. Colours are red (dark grey in photo) and green (light grey). Remnant *Chondrites* sp. burrows at lower left. (7-22-84-22W6).



Lime Wackestone of Debolt Formation. Fossil debris includes bryozoa (1), echinoderms (2), bivalves (3). Dark colour of enclosing lime mud thought to be caused by very fine bituminous or pyritic grains, rather than argillaceous material. (7-27-82-21W6).

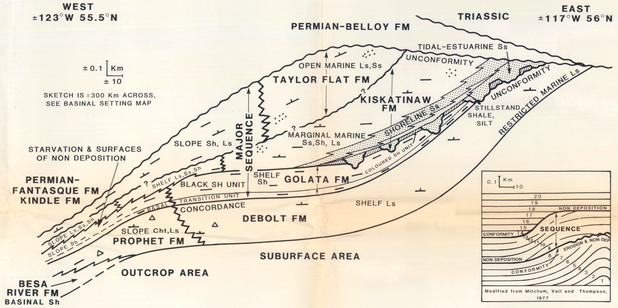


CORE PROFILE
6-27-84-13W6
6174 - 6518 ft
1882-1987 m.

Bedding and Structures
- crossbeds
- horizontal
- laminated
- rippled
- flaser
- wavy
- lenticular
- mud couplets
- burrowed
- syneresis
- nodular
- mottled
- cracks

Components
- limestone
- P packstone
- W wackestone
- calcareous
- shaly
- silty
- sandy
- carbonaceous
- roots
- shells
- oolites
- F fossils (mainly: Crin., Brach., Bry., Coral)
- rip-ups
- shale clasts

Trace Fossils
- CH *Chondrites*
- PA *Paleophycus*
- PL *Planolites*
- SK *Skolithos*
- TE *Teichichnus*
- TH *Thalassanoides*



Sequence Stratigraphy Model. Clastic pulse of Stoddart Sequence onlaps and locally erodes Debolt Fm., beginning with shelf shales of Golata Fm. Tidal/estuarine complex develops on landward side during upper Golata-Coloured Shale unit/basal Kiskatinaw time and erodes through Golata, into Debolt. Tidal/estuarine complex abandoned and capped by stillstand shale-siltstone marsh and tidal flat unit. Gradual transgression shown by shoreline facies resting on stillstand facies, followed by marginal and open marine units. Formation nomenclature reflects facies progressions. Sequence loses lithologic definition basinward. Compare with figure from AAPG Memoir 26.

CONCLUSIONS

The Golata Fm. comprises three units, in ascending order: 1) a thin basal zone transitional to underlying Debolt Fm. carbonates (Basal Transition unit); 2) a thick medial marine shale unit (Black Shale unit); 3) a thin upper shale unit representing a subaerial exposure zone (Coloured Shale unit).

The Golata Fm. shale - Debolt Fm. carbonate contact is conformable and the Golata Fm. shales mark the beginning of a major clastic pulse. This pulse continues upward resulting in sandy deposits of the Kiskatinaw and Taylor Flat fms.

The clastic-dominated units of the Stoddart Group constitute a depositional sequence beginning with the deposition of Golata Fm. shale.

The contact separating Golata Fm. shale from overlying basal Kiskatinaw Fm. sandstones commonly has the appearance of a disconformable contact, but represents localized cut and fill developed during deposition of basal Kiskatinaw sandstone and laterally equivalent uppermost Golata shale.

Petroleum traps are developed where reservoirs of basal Kiskatinaw channel sands are sealed laterally by off-channel shales of the upper Golata and basal Kiskatinaw and by normal faults cross-cutting the channel trends. The reservoirs are sealed vertically by floodplain/tidal flat shales capping the channels.

SUGGESTED REFERENCES: This poster is based on the following paper: Barclay, J.E., 1988. The Lower Carboniferous Golata Formation of the Western Canada Basin, in the context of Sequence Stratigraphy. *In* D.P. James and D.A. Leckie (Eds.), Sequences, Stratigraphy, Sedimentology, Surface and Subsurface. Canadian Society of Petroleum Geologists Memoir 15, p. 1-14.

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(Complete references in Barclay, 1988.)

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