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ABSTRACTS

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MARITIME SEDIMENTS AND ATLANTIC GEOLOGY
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Sediment-hosted Manganese in Newfoundland: settings and significance

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Sediment-hosted manganese occurs in three principal settings in Newfoundland: (1) an earliest Midle Cambrian shallow marine sequence within the Avalon zone, (2) allochthonous Lower Ordovician slope sequences within the Humber zone, and (3) Ordovician oceanic sequences within the Dunnage zone in central Newfoundland. The Avalon occurrences appear at the disconformable base of the Middle Cambrian, and consist of nodules and thin beds of Mn-carbonate within shale. In the deep-water slope sequences of western Newfoundland, Mn precipitation was localized in a late Tremadoc to Arenig interval along portions of the margin. Here Mn-carbonate was precipitated as discrete horizons within shale during shallow-burial diagenesis. Central Newfoundland examples also appear in the Lower Ordovician, but are most common in deep-ocean chert/shale sequences of Caradocian age, where Mn-carbonate and silicate occurs in intervals up to 50 m thick.

The sedimentary concentration of manganese is a redox-driven process which requires an Eh gradient to facilitate mobilization and subsequent precipitation. In the Cambrian, levels of dissolved oxygen sufficient to facilitate Mn precipitation were only widespread in the shallow marine environment. The later, deep water occurrences are consistent with an episode of "oceanic ventilation" in the Early Ordovician. This resulted in an Eh gradient at the seafloor which promoted precipitation during early diagenesis. Metamorphosed manganiferous beds (coticules) within the Appalachian-Caledonian orogen have been correlated with the enrichment of other metals and are commonly of inferred Early and Middle Ordovician age. While these may relate, in part, to an overall increase in hydrothermal activity they may also reflect early, redox-related redistribution of metals in oceanic sedimentary sequences.

Thin-skinned Thrust Tectonics along the Grenville Front, Western Labrador

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The Emma Lake area lies within the Grenville Front Zone in the parautochthon of the Grenville Province in western Labrador. In the Emma Lake area Archean crystalline basement rocks of the Ashuanipi Metamorphic Complex and Lower Proterozoic supracrustal sequences of the Knob Lake Group were folded and thrusted northwestward during the Grenville Orogeny. The map pattern represents an oblique section through the thrust stack, allowing for the construction of true profiles of the stack using down-plunge view projection. The geometry of the thrust stack is that of a northeast-plunging duplex with extensive basement involvement. This is the first time a duplex has been recognized in the Grenville Front Zone.

Horses in the duplex are thickest, typically 50 to 100 m, where they contain basement rocks; the combined duplex thickness is less than 400 m. Thrusts developed as ductile shear zones with southeast-dipping, southeast-plunging penetrative C-S-L fabrics. Northwest-verging, northeast- plunging mesoscopic F_1 folds above hangingwall ramps have a fold nappe geometry. Locally, mesoscopic F_2 folds refold earlier F_1 folds about a shallow, northeast-plunging fold axis.

Grenvillian metamorphic grade in the Emma Lake duplex is upper-greenschist facies. Kenoran granulite facies basement rocks were retrogressed along shear zones to biotite-rich mylonites and phyllonites, whereas the Lower Proterozoic cover sequence underwent prograde metamorphism. Exchange geothermobarometry was conducted on the Menihek Formation, a biotite - chlorite - garnet semipelitic schist of the Knob Lake Group.

Extensional Tectonics in Compressional Orogens: Late-stage Gravity Sliding of Ophiolite Thrust Sheets in Oman and Western Newfoundland

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Ophiolite complexes in Oman and western Newfoundland are the highest slices in transported stacks of ocean basin and continental margin rocks. The transported rocks overlie contemporary passive margin carbonates and their continental base-

ment. Overall lithologic and structural relations indicate assembly and emplacement of the transported rocks by foreland propagating thrusts. Ophiolite slivers show additional evidence for further transport after initial emplacement. Basal fault surfaces are sub-horizontal and show an overall extensional geometry, cutting down through underlying rock units and imbricate fault surfaces. Locally, the entire underlying imbricate stack has been structurally removed and the ophiolites rest directly on shelf carbonates. The ophiolite sheets are broken into a series of plates or blocks which occupy depressions adjacent to major structural culminations. The culminations were generated by late-stage thrusting along a sole thrust lying in continental basement. Structures generated during basement thrusting are truncated by the ophiolite sheets. Remobilization of the Oman and west Newfoundland ophiolites coincides, or immediately post-dates, basement thrusting and culmination formation. The ophiolites are interpreted to have moved from the crest of these culminations to the adjacent depressions on gravity-drive slide surfaces. In Oman, culmination formation and gravity sliding took place during the Late Cretaceous Alpine Orogeny and immediately post-date ophiolite obduction (arc/continent collision). In Newfoundland, ophiolite obduction and allochthon emplacement coincide with the Ordovician Taconian Orogeny but culmination formation and gravity sliding did not take place until the Devonian Acadian Orogeny.

Melt generation and evolution in Ophiolite Mantle and the development of mantle heterogeneities

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Mantle-derived melts are processed through a highly complex system prior to their consolidation in the crust and consequently, primary magmas are unlikely to be preserved. Preliminary studies of the segregations found in the tectonized mantle harzburgites of the Lewis Hills and Table Mountain massifs, Bay of Islands Ophiolite, indicate that they occur as bodies of dunite, orthopyroxenite, clinopyroxenite (containing native Cu and Fe-Ni sulphides), websterite, lherzolite, harzburgite, wehrlite and gabbro. These bodies exhibit cumulate textures with a tectonite overprint and are assumed to represent totally or partially crystallized melts of fairly primitive composition; some dunites are, however, residues left after partial melting. Primary magmas should exist as totally crystallized in situ partial melts, but will only be preserved if they acted as closed systems contained within low strain domains of ascending diapirs. Low strain domains are rarely preserved and segregations are frequently boudinaged and enveloped by mylonitic harzburgite. Consequently, the melts must have solidified to relatively rigid bodies during on-going mantle flow, with the result that the segregations were transported within high strain domains away from their original regime of formation. Within the mantle sequence, four types of lherzolite are distinguishable: (i) primary lherzolite, (ii) melt-infiltrated harzburgite or dunite, (iii) deformed and recrystallized olivine-, orthopyroxene- and clinopyroxene-bearing segregations, and (iv) harzburgite metasomatized during ophiolite obduction and emplacement. Only types (i), (ii) and (iii) can be considered as source rocks for basalt production in the ocean basins, and although initial primary magmas might be generated from mantle which may be homogeneous, later generations of primary magma will be produced from heterogeneous mantle. Banding and layering are both present in this heterogeneous mantle which is charged with pockets of trapped melt.

This abstract was recently presented in Cyprus as part of a poster display at the symposium: Troodos 87, Ophiolites and Oceanic Lithosphere.

Geologic Mapping and Mineral Exploration Using Remote Sensing Techniques

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The increasing costs involved in conventional geologic mapping and mineral exploration over the past 20 years has given rise to a substantial increase in the development of faster and more inexpensive data collection techniques. Airborne and satellite-borne sensors have previously, and continue to provide large volumes of geologically useful data such as spectral, magnetic, gravimetric, and gamma-ray spectrometric. Conventional analogue maps, tables, and overlays are relatively inflexible and inefficient means of dealing with the large quantities of geologic information. Digital image processing techniques have significantly improved the integration and manipulation of both remotely sensed and conventional geologic data (lithological, structural, geochemical). These digital databases can provide valuable insights into the lithologic and structural relationships of an area and are useful reconnaissance tools for geologic mapping and mineral exploration programs.

The Carboniferous Bay St. George Subbasin, western Newfoundland: Structural interpretation from a geophysical perspective

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The Bay St. George Subbasin of western Newfoundland represents the northeast extension of the Maritimes Basin which opened by northeast right-lateral wrench tectonics along the Cabot Fault system initiated during Devonian time. Gravity, magnetic and reflection seismic data were compiled and interpreted to determine the basement structure and the present configuration of intra-basin lithologies for the offshore portion of the subbasin.

Negative gravity gradients correlate with increasing depth to seismic basement to delimit the offshore subbasin structure as a southeast dipping half-graben filled with up to 5 km of low density Codroy (Mississippian) sediment. The half-graben terminates against a northeast oriented high-angle fault at the southeastern coastline of St. George's Bay, which uplifts magnetic basement onshore. Basement structure can be traced northward onto the Port au Port Peninsula on the basis of magnetic signatures.

A series of east-west dextral strike-slip faults has altered the subbasin structure, displacing late Mississippian sediments and earlier structural features on the order of 5 km. This overprinting relationship may indicate fault reactivation during late Pennsylvanian time.

The Stratigraphy and Sedimentology of the Connecting Point Group and related rocks, Bonavista Bay, Newfoundland: An example of a Late Precambrian Avalonian Basin

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The Connecting Point Group in the Bonavista Bay area is composed of <3.5 km of Late Precambrian epiclastic, marine turbiditic sandstone, siltstone, shale and silicified sediment; pyroclastic sediment is intercalated in the lower 500 m. Six lithostratigraphic units and ten distinctive lithofacies are recognized. Lithofacies were deposited in basinal and slope settings, prograding fan lobes and channel-levee complexes of submarine fans. Predominance of Ta turbidites and poor development of sequences in the lower 800 m of the group suggest that sediments were deposited on low-efficiency submarine fans as part of a thick volcaniclastic apron that lay adjacent to a volcanic centre. The well-developed channel-levee complex of the next 1000 m of the succession suggests a change to a more efficient fan with time. A shale transition containing thin siltstones and cherts, small to large scale slumps, and a regionally significant olistrostromal mixtite deposit overlie the lower sequence. Above the transition, a sequence of silicified, classical turbidites are arranged in stacks of coarsening- and thickening-upwards sequences, suggesting the existence of a series of well-developed, overlapping, prograding submarine fan lobes. The separation of the sediments into two distinct sequences coincident with: (1) introduction of mixtite into the basin; (2) intrusions of mafic dykes and plutons; and (3) influx of coarse volcanic detritus indicative of volcanic source uplift, suggests an episode of basin extension. The lithostratigraphy and characteristics of the upper part of the underlying Love Cove Group and of the Connecting Point Group resemble Cenozoic models of sedimentation of volcanic arc basins. The linear Precambrian volcanic and sedimentary belts in the Avalon Zone may reflect an ancient arc-basin geometry affected only slightly by subsequent deformation.

The Genesis of Fjords on the south coast of Newfoundland - New Possibilities

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Many fjords are the result of glacial modification of pre-existing ancient fluvial valley systems. Although we lack sufficient hard data, the fjords on the south coast of Newfoundland west of Fortune Bay appear to have a somewhat different genetic history. A number of different observations provide a basis for this interpretation. (1) There is a broad zone of bare rock that is at least 30 km wide parallel to the south coast that extends westwards to Port- aux-Basques. (2) The walls of the fjords are oversteepened (overhang). (3) Most of these fjords have an extremely deep depression near their mouth.

These three major observations provide the basis for a more comprehensive interpretation of fjord genesis than simply glacial erosion. It is suggested that the absence of surficial sediment from the near-coastal zone of the south coast is the result of erosion by subglacial sheet flow subsequent to glacial modification of the pre-existing morphology. This high pressure water was channelized where it intersected major subglacial river valleys. The oversteepening of fjord walls and the excavation of deep depressions near fiord mouths were accomplished by sediment-laden high pressure water in a process similar to sand blasting.

This hypothesis has significant implications to the interpretation of glacier mechanics and the glacial history of southern Newfoundland.

Deep Crustal Structure of the Newfoundland Appalachians

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Two marine deep seismic reflection experiments have been carried out in the vicinity of Newfoundland: a 1000 km traverse northeast of the island between the Labrador coast and Orphan Knoll during 1984; and an 1100 km grid of lines in the Gulf of St. Lawrence during 1986. This work, done as part of Lithoprobe East, has provided new insights into the structure and tectonic evolution of the crust and upper mantle to depths of approximately 50 km.

The lower crust seen on the 1984 line can be divided into three major blocks. The most northwesterly of these is the deep manifestation of the Grenville craton and can be traced beneath the Dunnage zone for approximately 70 km east of the Baie Verte - Brompton line. The most southeasterly block is the deep manifestation of the Avalon zone, being bounded on the northwest by a crustal scale strike-slip fault spatially correlative with the Dover fault. The intervening deep crustal block, referred to as the Central Block, underlies the surface expression of both the Gander zone and the eastern half of the Dunnage zone. The Dunnage zone, therefore, is seen as allochthonous on both the Grenville and Central Blocks.

The same pattern of lower crustal blocks is seen on the 1986 data gathered within the Gulf of St. Lawrence and its approaches. The continuity of this structural pattern along strike implies that the lower crustal blocks are related to the Paleozoic surface zones and that both lower blocks and surface zonations had their origin in a common set of Paleozoic tectonic processes. The deep structure of the Appalachian orogen can be followed around the orthogonal bend of the St. Lawrence promontory. The promontory appears to have played a major role both in determining the location of the Carboniferous Magdalen basin and in converting the orogen from a subaerial to a submarine expression within the Gulf of St. Lawrence.