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the highest concentrations of uranium have similar $\delta^{18}O$ values but much lower δD values (ca. -170) that cannot be related to normal basinal waters. Illites having low δD values also have young K-Ar ages of 400 Ma and higher water contents than do those with more "normal" δD values, suggesting that the interlayer sites in the illites have been hydrated by this later fluid. Water extracted from the interlayer sites of illites with low δD values has low $\delta^{18}O$ and δD values similar to those of present-day meteoric waters found throughout the Athabasca Basin. These relations suggest that the unusually low hydrogen isotopic compositions of some of the clays are probably not the result of some chemical reaction involving organic material associated with the precipitation of the uranium, but are related to fracture permeability in the host rocks and to the influx of modern ground water that has reacted with the clays.

THE ORE PETROLOGY AND GENESIS OF A STRATABOUND DISSEMINATED COPPER DEPOSIT AT SUSTUT, BRITISH COLUMBIA

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The Sustut Copper Deposit of north-central British Columbia occurs in the upper member of the Upper Triassic Mooosevale Formation, Takla Group, a unit composed of volcanic conglomerate and breccia with local tuffaceous layers. Metamorphic grade of the host rocks is of the prehnite-pumpellyite facies. This grade is higher than that of the same unit at equivalent stratigraphic levels elsewhere in the area. The copper minerals, mainly chalcocite, bornite, chalcopyrite and native copper, are epigenetic and occur with quartz, epidote, prehnite and carbonate in veinlets and in tabular zones parallel to bedding. Pyritized rock surrounds some copper-bearing tabular zones. A crude vertical zonation is apparent in the tabular zones, which grades from margin to core as: pyrite-chalcopyrite-bornite-chalcocite-native copper. The tabular copper zones and local sets of veinlets appear to have formed interconnected channelways permeable to ore fluids that presumably were derived from below. Sequential development of ore minerals as indicated by paragenetic studies and the observed zonal distribution requires an ore fluid initially more oxidizing than the basaltic country rock. The upward flow of the hydrothermal solutions within a structural zone defined now by swarms of Cu-bearing veinlets produced a confined geothermal high that resulted in a local node of prehnite-pumpellyite facies metamorphism and concomitant development of copper minerals and pyrite. The tabular zones represent loci of fluid-wallrock reaction and the ore-mineral zoning may be attributed to diffusion outward from these loci.

AN ALLUVIAL APRON AND PLAYA-MARGIN INTERPRETATION OF Cu- AND Ag-BEARING SEDIMENTARY ROCKS, MIDDLE PROTEROZOIC BELT SUPERGROUP, MONTANA AND IDAHO

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Copper and silver deposits of the Ravalli Group and middle Belt carbonate (Belt Supergroup) occur in sediments interpreted to be alluvial apron and playa-flat sequences. Critical to this interpretation is the recognition of fining-upward sand-to-mud sequences, metres to centimetres thick, that were deposited by episodic floods and that thin basinward. Cross-bedded medium- to fine-grained sand beds of the Revett Formation record braided streams that drained a continental terrane that lay west (present direction) of the Belt basin. Braided streams flowed across alluvial aprons that sloped northward and eastward toward the centre of the intracratonic basin. Channelized floodwaters approaching the toe of the apron spread into sheet floods, depositing flat-laminated sand beds from the upper flow-regime, capped by mud drape deposited during waning flow. Floods crossing the distal sandflat deposited either fining-upward sand-to-mud sequences decimetres thick or poorly sorted muddy layers with discontinuous clay and silt laminae. Continued flow across the playa mudflat deposited silt-to-clay couplets centimetres thick that were subsequently mud-cracked. Coarse sand, derived from the stable North America craton, was deposited along the eastern margin of the basin in fluvial channels, sheet-flood layers and ephemeral, locally oolitic beaches. Barrier island and tidal channel deposits, characteristic of marine coastlines, are absent; instead, the sequence closely resembles recent and ancient alluvial fan and playa deposits. The vertical sequence from alluvial aprons and sandflats of the Ravalli Group upward into playa mudflats of the lower middle Belt carbonate records progressive expansion of the playa sea. Sediment-hosted copper and silver deposits in the Ravalli occur in braided-stream and sheet-flood deposits of the alluvial apron in the western part of the basin (Revett Formation). Mineral deposits in the uppermost Ravalli and lowermost middle Belt carbonate occur in quartz sand and oolite of channels, sheet-flood deposits and ephemeral beaches.

MIDDLE TO LATE PROTEROZOIC (1.8-0.6 Ga) SEDIMENTATION, NORTH AMERICA

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The Middle to Late Proterozoic records 1.2 Ga of sedimentation similar in complexity to the Phanerozoic. Post-Hudsonian (1.8 Ga) basins from lower Coppermine Homocline to North Greenland, and Athabasca, Thelon, Great Lakes area, and New Mexico contain one or more rift-related, unconformity bounded sequences of coarse-to-fine quartzose alluvial deposits overlain by marine sandstones, stromatolitic carbonates and local bimodal volcanics (1.66 Ga in Coppermine Homocline).

Thick Middle Proterozoic sequences of uncertain maximum age accumulated in the Tuchodi Lakes area and Ogilvie-Wernecke Mountains of NW Canada; in northeast Greenland; and in 5 or 6 trough-like basins of western USA; (including the Belt-Purcell Supergroup). Strata are shallow water to subaerial; medium-to-fine siliciclastic, stromatolitic and silty carbonate, local dark turbidite arenite, and thinly laminated dark mudstone.

In eastern North America, post-Hudsonian granites were intruded at 1.65-1.60 Ga. In Labrador, two rift-related, unconformity-bounded sequences comprise terrestrial arkoses and mafic-to-felsic volcanics. The older sequence is intruded by 1.5-1.4 Ga anorogenic granites and anorthosites.

Rift-related basalt and clastic sequences occur at 1.3 to 1.1 Ga in many of the above areas (e.g. Coppermine and Keweenaw). Younger strata (1.2-0.7 Ga) in northwestern Canada bridge Middle and Late Proterozoic time with platform siliciclastics, carbonates and evaporites. To the southeast the Grenville Central Metasedimentary Belt records orogeny at 1.3 Ga; siliciclastic to carbonate and evaporite sedimentation punctuated by mafic-to-felsic volcanism at 1.29 Ga; orogenies at ca. 1.2 and 1.1 Ga; a second clastic-to-carbonate cycle; and folding with metamorphism at ca. 1.08 Ga.

In Mackenzie Mountains, rift-related basalts, conglomerates, red beds, carbonates and evaporites younger than 0.8 Ga (e.g. Redstone Copper Belt) record a warm climate, as do underlying strata. Immediately following, more extensive rifting was accompanied by local volcanism, and deposition of glaciomarine with other immature detritus in basins extending the length of the Cordillera. Similar deposits also occur in eastern Greenland. Overlying carbonates and siliciclastics are, in turn, separated by local unconformities and conglomerates from Phanerozoic marine strata of similar style and longitudinal extent.

Significant stratabound sediment-hosted copper deposits occur in reduced facies of thick, dominantly red bed sequences that record restricted marine and/or lacustrine sedimentation, extensional tectonism in continental settings, and arid climates.

ANCIENT QUARTZITES AND CARBONATES IN NORTHWESTERN ONTARIO - EVIDENCE FOR EARLY (ARCHEAN) CRUSTAL STABILITY?

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Quartz arenite and limestone, uncommon in the Archean record, occur at North Spirit Lake and Eyapamikama Lake; carbonate, much of it stromatolitic, occurs at Red Lake, Uchi Lake, Lumby Lake, and Atikokan; quartzite occurs at Armit Lake. Such sediments form the lower parts of the greenstone belts. In the Sachigo Subprovince these sediments are overlain by komatiites, primitive tholeiites, and iron formation. The younger portions of the belts are areally more extensive and better preserved. They are separated from the older sequence by an unconformity or disconformity; are typically composed of immature, deep water sediments and usually bimodal volcanic suites with tholeiites as the mafic component.

U/Pb zircon geochronology at North Spirit Lake indicates the quartz arenites formed between 2966 and 2800 Ma. Stromatolitic carbonates at Red Lake are 2940 Ma to 2925 Ma old, and at Uchi Lake similar rocks overlie 2840 Ma rhyolite. At Lumby Lake carbonate overlies 2999 Ma volcanic rocks. This suggests volcanics associated with mature quartzose or carbonate sediments are 3 Ga. Volcanics and immature sediments in the upper parts of greenstone belts are <2,755 Ma.

These mature sediments were deposited in shallow water, under tropical to sub-tropical conditions, with low relief in the provenance areas and reflect a stable crust environment. Their distribution suggests extensive sialic crust at about 3 Ga.

Judging by the primitive volcanic rock types associated with the quartz arenites and carbonates, the thickness of the crust at 3 Ga was less than that underlying greenstone belts during post 2755 Ma volcanism and sedimentation. The earlier crust was more stable. This suggests that tectonism and igneous events associated with younger greenstone belts were more catastrophic than those of earlier volcanism and sedimentation.

Other shield areas, such as India, South Africa and Australia had similar secular sedimentary, volcanic and tectonic patterns. The stable phase envisioned for the NW Ont. craton at 3 Ga may be equivalent to the platformal stage proposed for the Western Australian Shield by Groves and Batt (1984).

EXPERIMENTAL DATA BEARING ON THE SEPARATION OF GOLD AND BASE METALS IN ARCHAEAN GREENSTONE BELTS

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Recent multiphase solubility data for the assemblage pyrite+pyrrhotite+magnetite+galena+sphalerite+stibnite+gold+argentite+bismuthinite+molybdenite in NaCl-CO2-H2O solutions allow some observations regarding the reported separation of gold and the base metals (Cu, Zn, Pb) respectively, into lode gold and massive sulfide type mineralization in Archaean greenstone terrains. The ratios Zn/Au, Pb/Au and Ag/Au were calculated for 0.5, 1.0, 2.0, 3.0, 4.0 & 5.0 molal NaCl solutions in equilibrium with the above assemblage. Zn/Au and Pb/Au are highest in 0.0 m NaCl solutions (Zn/Au = 50-200; Pb/Au = 5-40), go through a minimum at about 0.5 m NaCl (Zn/Au = 1-8; Pb/Au = 0.9-1.2) and then slowly increase again with NaCl concentration. Ag/Au was also highest in 0.0 m NaCl (5-20) but then decreased to about 0.1-0.6 and levelled off. This data suggest that a solution which is near saturation with respect to galena, sphalerite and gold will carry the highest percentage of gold relative to the other metals when NaCl=0.5 molal or approximately 3 wt. %. The salinities obtained from fluid inclusions in Archaean lode gold deposit are generally 3 wt. % or less. Thus the conditions of transport and deposition of gold in these deposits correspond to the minimum in Pb/Au and Zn/Au. However, these ratios are never significantly less than one so some other mechanism must be operative in enriching gold relative to Zn and Pb (and Cu by analogy). Although the experiments were performed at 200-350 deg C, it is unlikely that slightly higher or lower temperatures will significantly affect the results.