meetabst\ICAMIVb.sam/pdf Talk given at Intl. Conf. on Arctic Margins IV, Bedford Inst., Halifax, NS. 29th Sept-3rd Oct 2003. Conference abstracts p.38-39. Corresponding ms. for conference volume submitted Dec 2003.

Some tools for plate kinematic analysis of the wider Arctic region and its basin systems since the Riphean

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Any attempt to work out the plate kinematic evolution of the Arctic region since about 750Ma lacks proper constraints if one has to imagine the deeply subsided continuation of orogens beneath the huge shelf and basin areas that surround the Arctic ocean and continue far into western Siberia. Here I offer two basic interpretive tools for a more directly constrained analysis that gives new significance to the basin configurations.

First is my recognition of how basal subduction tectonic erosion (STE) can extensively undercut margins and of its relevance to collision orogens. Active STE can advance the locus of the would-be arc so fast (~30km/Ma currently in the 'flat-slab' Andes) that arc magmas are distributed at crustal base without attaining surface. Hence, long before a collision, a margin may be extensively undercut by STE, forming nappes-in-the-making, without any magmatism sign that this has happened. A further result is that the undercut margin may imbricate; already cooled by the flat subduction beneath it, slices of it will readily subduct to HP/LT mineralogy, lodging across the downbend curve carved into the hanging wall.

I offer briefly the Alps and E Greenland-Scandian Caledonides as prime examples of the structural outcomes. They differ in that the Caledonides had subduction under both margins, with the HP/LT belt being built under the second one (Greenland) and thrust onto Norway (Western Gneiss). This and other features make structural sense only if the present shelves did not exist at the moment collision was complete, but were basins formed immediately thereafter (early Devonian) by fresh separation, passing E of Svalbard.

This needs the second tool. I outline the observational basis for the purely separative (pseudo-MOR) generation, in the presence of even minor sedimentation, of what I have called intermediate crust (IC). This is thicker, has sills, no MOR-type magnetic anomalies, a basement looking seismically like stretched continental crust and a thickness that can ultimately exceed 27km. The finding that all tectonic plates, from cratons to young oceanic ones, are much thicker than previously thought, means that plate-cooling and subsidence of intermediate-crusted areas (= 'continental basins') now involves mantle phase change and can be very protracted (>200Ma?). Collisions and arc magmatism may convert IC into mature continental crust (MCC).

The other facet of this analytical tool is the different epeirogenic behaviour of MCC which I show to be far more sensitive to thermal input, thereby making even quite small block-inliers of MCC self-evident by exposure or as highs. This means that plate kinematic analysis (PKA) now includes two aims; making geotectonic sense of the known units/blocks of MCC, and precisely creating the observed intervening shapes and areas of IC, allowing for any later loss by subduction. Already used at smaller scale, the Arctic region offers a major test of PKA.

Presentation type: Oral