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HOW WIDELY IS THE ANDEAN TYPE OF CONTINENTAL MARGIN REPRESENTED IN THE ARCHEAN? Kevin Burke, Lunar and Planetary Institute, 3303 Nasa Road One, Houston, TX 77058 and Department of Geosciences, University of Houston, University Park, Houston, TX 77004

Continents are elevated above the ocean floor because continental crusts are made up of material lighter than the overwhelmingly basaltic oceanic crust. The great bulk of igneous rocks less dense than basalt forming today is made at convergent plate boundaries and for this reason processes at convergent boundaries are considered most likely to have been dominant in the production of the continental crust.

Convergent plate boundaries can be characterized as: Island arcs, Andean Margins and Collision zones (both arc-continent collision zones and continent-continent collision zones). Only island-arc convergent boundaries can originate entirely within the ocean (perhaps nucleating on oceanic fracture zones) and for this reason this type of boundary is likely to have been involved in forming the world's first "continental crust" at more than 4 Ga. Compositions of rocks formed at island arc boundaries in the Late Phanerozoic (for example, the Greater Antillean Island Arc [1] show close resemblances to some Archean rocks and it seems likely that this kind of material is widely represented within the Archean although some differences in source magmas and in proportions of rock types have been suggested.

Andean and collisional convergent boundaries are likely to involve (1) contamination of material newly-derived from the mantle by material already in the continental crust and (2) partial melting of that crust. These processes produce recognizable geochemical signatures (e.g. high initial strontium isotopic ratios) which are widespread among Archean rocks.

It therefore seems possible that Andean margins and both kinds of collisional boundaries are represented within the Archean and I here draw attention to a simple structural criterion that may be applied to discriminate between Andean margins and continental collision zones. Continental collision zones are enormous in area (10^6 km^2) (e.g. Tibet today) and have been so in the past, (e.g. the Grenville Province and the Pan African). It is hard to recognize such huge areas among Archean rocks because of the limited extent of most preserved Archean provinces, but the 0.5×10^6 km^2 area of granulite within the Superior Province of Labrador is the most likely candidate. By contrast, Andean margins are long ($\sim 10^3$km) and narrow (as the Andes today) and volcanism within Andean provinces is usually restricted to a narrow zone less than 100 km wide expanding to a broader area (such as in South America today) only in areas of extreme shortening of the basement [2].

The Phanerozoic history of the Andes shows that apart from rafting in of arc and microcontinental material ("terranes" of some authors) which was important in the Paleozoic in the South [3] and has been important again within the last 100 Ma in the North [1], there have been episodes of crestal rifting [4] and marginal basin formation [5] within the Andean arc. Possible analogues of these features are common in the Archean record (e.g. 6).

In summary: Andean margins are likely to be recognized in the Archean as: (1) the site of abundant granodioritic to granitic intrusions with either or both of mantle and older continental isotopic signatures, (2) occupying a length of hundreds of kilometers, but (3) only a width one or two hundred km, (4) cut by mafic dikes representing episodes of extension within the arc, (5) the site of crestal-rift volcanic rocks (like those of Taupo in New Zealand, e.g. [ref. 6] and, (6) the site of marginal basins (like the Rocas Verdes [5]).

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Although it is clear that no Archean Andean margins can have survived within continents, Andean margin remains have been recognized in the Superior Province of Canada [ref.7] and the Closepet "granite" of Southern India may represent another example. It seems possible that Andean margins may be rather widely represented among Archean rocks and that there are good possibilities of recognizing them on structural grounds, perhaps complimented by compositional evidence. It seems clear that compositional evidence alone will always be ambiguous because it cannot distinguish Andean from collisional environments [pace, ref. 8].

REFERENCES

1. Burke, K. Tectonic evolution of the Caribbean. Ann.Rev.Earth & Planet.Sci. In press.
2. Sengor, A.M.C., Altiner, D., Cin, A., Ustaomer, T. and Hsu, K.J. Origin and assembly of the Tethyside orogenic collage at the expense of Gondwana-Land. Proc. First Lyell Symp. on Tethyside Gondwana-Land. Geol.Soc. London. In press.
3. Ramos, V.A.,Jordan, T.E.,Allmendinger, R.W., Mpodozis, C., Kay, S.M., Cortes, J.M., Palma, M. 1986. Paleozoic terranes of the Central Argentine-Chilean Andes. Tectonics 5 (6) 855-880.
4. Maze, W.B. 1984. Jurassic La Quinta formation in the Sierra de Perija northwest Venezuela: Geology and tectonic movement of red beds and volcanic rocks. In the Caribbean-South American Plate Boundary and Regional Tectonics. ed. by W. E. Bonini, R.B. Hargraves, and R. Shagan, Colorado. 421 pp. Geol. Soc. Am. Mem. 162, 263-82.
5. Dalziel, I.W.D., 1981.Back-arc extension in the southern Andes: a review and critical reappraisal. Phil. Trans. Royal Soc. Lond., A300: 319-335.
6. Thurston, P.C., Ayres, L.D., 1986. Volcanological constraints on Archean tectonics. In Workshop on tectonic evolution of greenstone belts eds. M.J. deWit, L.D. Ashwal, Houston. LPI Technical Report 86-10,207-209.
7. Card, K.D. 1986. Tectonic setting and evolution of Late Archean greenstone belts of Superior Province, Canada. In Workshop on tectonic evolution of greenstone belts, eds. M.J. deWit, L.D. Ashwal, Houston. LPI Technical Report 86-10, 74-76.
8. Pearce, J.A., Harris, N.B.W. and Tindle, A.G. 1984. Trace element discrimination diagrams for the tectonic interpretation of granitic rocks. Jour. Petrology 25, 956-983.