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Crustal recycling in accretionary orogens – the example of the Paleozoic Gondwana margin in the region of the southern Central Andes

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During the entire Phanerozoic the western margin of South America has been facing the open ocean. In the southern Central Andes, most of this time active margin processes governed the style of basin development, deformation, magmatism, and metamorphism. An exception is very likely the Silurian to Early Carboniferous interval for which a passive margin setting is suggested. It has been a long accepted view that depocenters and magmatic arcs migrated westward during the Paleozoic, and eastward in the Mesozoic and Cenozoic. This seemed to suggest continental growth by terrane accretion during the Paleozoic. This view was strongly influenced by the recognition of the accretion of exotic terranes to this margin south of c. 27˚S during the Paleozoic. Generally, terrane bounding faults and sutures represent first order crustal discontinuities. Regarding the southern Central Andes, however, most, if not all, of the proposed Paleozoic terrane boundaries failed their tests.

A re-examination of the basic tenet of westward migration of basins and arcs during the Paleozoic demonstrates that the Ordovician continental magmatic arc, the subsequent Late Ordovician Oclóyic orogen acting as the Arco Puneño positive area in the Silurian to Early Carboniferous, and the Late Carboniferous-Permian continental magmatic arc all occupy essentially the same area. These elements are now contained within the Cenozoic continental arc. Paleozoic basins and depocenters are also located in relatively constant positions east and west of arcs and Arco Puneño. The same holds true for the position of subduction trenches in the Ordovician, Late Carboniferous and the Cenozoic. Only during the Jurassic and Cretaceous was the trench located outboard of present-day continental margin. This Mesozoic fore-arc has been eroded since by subduction erosion.

Geochemical and provenance studies of the Proterozoic metamorphic basement, the Neoproterozoic and Paleozoic sedimentary cover and the coeval magmatic rocks emphasize the temporal and spatial homogeneity of the evolved geochemical compositions of the respective rock units throughout the Paleozoic. There is a notable scarcity of mafic magmatic rocks indicating the minor role of juvenile crust formation from the Neoproterozoic to the Triassic. This is also bourne out by the lack of pronounced secular compositional trends in the sedimentary record. Even though feldspatic sandstones and greywackes are abundant in the Ordovician, Neoproterozoic and Paleozoic deposits are generally relatively quartz-rich.

In the Paleozoic sedimentary rocks and granites there is a spread of ?Nd values of between –1 and –12, with averages between –5 and –8. This suggests input from juvenile sources at least in some samples. Nd model ages of the sedimentary rocks and their metamorphic basement cluster between 1400 and 1800 Ma and vary between 1200 and 2200 Ma. Together these data attest to a dominance of old, i.e. Meso- and Paleoproterozoic and probably Archaean crustal domains in the source regions of the deposits, a conclusion also supported by a first set of U-Pb SHRIMP ages and Lu-Hf isotope data on detrital zircons obtained from related rocks in the southern Andes.

In summary the combined data sets indicate (i) that the Neoproterozoic and Paleozoic crust of the southern Central Andes had a relatively homogenous and evolved geochemical composition, (ii) that its plate tectonic evolution was dominated by crustal recycling over the formation of new crust by addition of juvenile magmas, and (iii) that a probable segmentation of the crust by structural discontinuities is not due to the hitherto proposed Phanerozoic allochthonous or even exotic tectonostratigraphic terranes.