Climate change in the southern central Andes at 8 Ma

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Being situated in a subtropical high-pressure region with atmospheric subsidence and cold upwelling along the western coast of the continent, the southern central Andes are extremely arid between about 15°S and 27°S. About 20mm/yr rainfall and low erosion rates characterize the Atacama Desert on the western flank of the orogen. With hyper-aridity in this region and less than 200mm/yr rainfall on the adjacent intra-Andean Puna-Altiplano plateau and in the intermontane basins E of the Puna, the southern central Andes thus comprise the most arid sector of the orogen. Despite this inherently arid character, the eastern flanks of the ranges intercept moisture-laden, easterly winds that result in up to 3000mm/yr precipitation. The cause and the timing for the establishment of this pronounced asymmetry is not known, however. Here, we report on stable C-isotope data obtained from paleosols developed in foreland-basin strata of S Bolivia that serve as proxies for paleoclimatic conditions along the eastern flanks of the Andes. Tephras in these sediments provide the chronostratigraphy for the paleoenvironmental evolution. In two sections our preliminary data show delta $\delta^{13}C$ values that both decrease from -7 to -8‰ to -11 and -13‰ between about 12.5 and 8 Ma, before they become less negative with an average of -10‰ in the remainder of the profiles. The relatively rapid ~4‰ change in $\delta^{13}C$ is attributed to a greater availabilty of moisture and increased climatic variability in this inherently dry area of the Andes. Our data suggest that the landscape was characterized by a mixed C3/C4 vegetation cover since approximately 8 Ma. Moisture availability must have been similar to the present humid conditions with a dry winter season. Holocene $\delta^{13}C$ values are between -9 and -10‰, thus indicating the dominance of a moisture stressed C3/C4 vegetative cover. Thus, present-day atmospheric circulation patterns and the distribution of rainfall are similar to the conditions during late Miocene time. Based on these observations we suggest that precipitation in the southern central Andes was associated with the South American Monsoon and increased at about 8 Ma. We suggest that enhanced precipitation in this region was closely linked to uplift of the Puna-Altiplano and its adjacent eastern orographic barriers that forced the southward displacement of easterly moisture-bearing winds via the Low Level Andean Jet.

Gabbroic bodies in the Trinity Ophiolite

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The Trinity Ophiolite (N. California) displays discrete silurian to devonian gabbroic bodies hosted by mantle rocks. It might be a good on-land analogue to test the applicability of current accretionary models for slow spreading systems. We report here first results from a mapping campaign in a northern (China Mtn.), central (Bear Creek) and southern gabbroic body (Bonanza King). The central body contains the most regular vertical lithological sequence: mantle peridotite; a shallow dipping transition zone with thick pyroxenitic layers; foliated gabbro; vary-textured gabbro. The northern body displays a disrupted transition zone separated from vary-textured gabbro by plastically deformed amphibolized gabbro. The strain is potentially related to extensional ridge tectonics. The southern body exhibits small exposures of wehrlitic and pyroxenitic rocks overlying mantle peridotite; gabbro and gabbronorite with a mineral foliation subparallel to the local dykes; vary-textured gabbro; doleritic dikes and sills. Two kinds of lateral contacts are observed. (1) Xenolithic margins, described by Cannat *et al.* (1991), demonstrating brittle behavior during emplacement into a cold lithosphere. (2) Dyke-like pyroxenites intruded between mantle peridotite and gabbro. No magmatic strain is obvious. We interprete this as a reactivated contact because of the sharp, sheet-like marginal zone. An inhomogeneous succession of rare peridotite; pyroxenite; doleritic dykes and vary-textured gabbro occurs at the topographic highest parts of two bodies and might represent a roof position. The disrupted character of the transition zones in the northern and southern body suggests the presence of multiple intrusive events which probably caused displacement of existing rock units. Specifically, it is our impression that the abundance of pyroxenites and primitive gabbros is too low relative to the exposed volume of evolved gabbro if a regular, mantle-derived magma is assumed.

Reference

Cannat, M., and C. Lecuyer, 1991: *Tectonophysics*, v. 186, p. 313-328.