U-Pb dating of very low-grade metamorphic titanite

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Titanite is a common secondary mineral present in metabasites in the Chilean Andes. Its rather high closure temperature (<550°C) renders it very suitable for dating sub-to-low-grade metamorphism or hydrothermal alteration. In this study we tested the feasibility of dating very small grains of secondary titanite. Thirteen standard petrographic thin sections of Mesozoic volcanic rocks outcropping in the Main and Coastal cordilleras of central Chile (33-35°S) were selected for U-Pb dating by LA-MC-ICP-MS. The analyzed titanites occur as four different varieties: infilling amygdales or veins, within the groundmass, and replacing both former pyroxene and magnetite phenocrysts. The radiogenic Pb content is generally low and correlates with the type of titanite, i.e. the large titanites within amygdales (~200 μm) contain the most radiogenic Pb. The mean ages range from 48.5±6.5 to 147±22 Ma, with three distinct groups at 102-108 Ma, 80-85 Ma, and 49-62 Ma. One sample from the Coastal Cordillera yielded an age of 119.8±3.6 Ma (Fig. 1). The U-Pb ages do not correlate with either the amount of common Pb, or with the varietal type of titanite (Fig. 1). The U-Pb ages overlap with those previously obtained by K-Ar and Ar-Ar methods, which have been attributed to either very low-grade metamorphism, or approach the age of volcanism; however, several samples yield Cenozoic ages, which may represent a geologic event or related to secondary Pb loss.

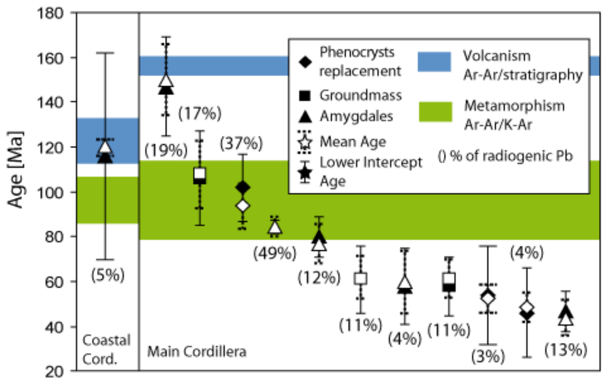

Figure 1: Titanite U-Pb ages.

Low biodiversity tropics in a high CO_2 median Mesozoic world

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A strong latitudinal gradient in biodiversity, increasing to the tropics, is one of the most striking of modern ecological patterns. Late Triassic to Early Cretaceous tropical assemblages do not show this pattern, however. Most tropical and subtropical floral records from this time are characterized by low diversity and are overwhelmingly dominated by cheirolepidaceous conifers and their pollen, *Classopollis*. These conifers have been traditionally described as arid-adapted with features such as microphyllus leaves and thickened cuticle with sunken or papillate stomata. While some subtropical occurrences of cheirolepidaceous conifers are indeed associated with sedimentological evidence for aridity such as evaporites, many from the tropics are not and instead are found in settings incompatible with aridity. In contrast, the temporal distribution of these low-diversity assemblages tracks Mesozoic CO_2, rising through the Triassic and falling through the Cretaceous as angiosperms become more prevalent. We suggest that these conifers were not so much arid-adapted, but rather specialized in extraordinarily hot, high-CO_2 environments, regardless of precipitation.

The same pattern maintains at finer time scales. The end-Triassic extinction (ETE) exhibits a dramatic drop in biodiversity at pulsed 2-3X increases in CO_2 associated with Central Atlantic Magmatic Province (CAMP) basaltic eruptions. *Classopollis* massively increased in the tropics and subtropics as generic diversity of other pollen and spores dropped in direct association with the eruptions. However, perennial lake sediments and other indications of an enhanced hydrological cycle increased dramatically at the same time consistent with high CO_2 and extremely hot temperatures, being the main drivers of cheirolepidaceous dominance and low biodiversity, not the lack of water.

High latitudes had dramatically higher diversity. At the ETE, these assemblages also suffered a huge drop in diversity among broader leaf forms consistent with thermal damage, but they never became as skewed as the tropics. Thus, relative to now, latitudinal diversity gradients were reversed at all temporal scales during times of very high CO_2, plausibly because of near lethal temperatures.