Authigenic titanite in paleosols indicates elevated temperatures and low atmospheric CO_2 levels

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Secondary titanite forms during weathering of Paraná basalts under hot and humid tropical climatic conditions in the southeast of Brazil [1]. The grains of up to 170 μm deposit together with Fe-rich clay minerals, chalcedony and barite. There are no carbonate minerals in the weathering profile. In contrast to titanites of magmatic and hydrothermal origins, the found specimens represent the elevated Al_2O_3, Eu/Eu*, and La_N/Yb_N and low abundances of Y, ΣREE, Zr, Th, and U. Using methods of geochemical modeling, we reveal that those titanites are genetically related with dissolution of plagioclase and precipitate from oxygen-free and high-pH pore fluids. Calcite accumulates in the course of weathering of basaltic rocks at moderate climatic conditions. The transition from calcite to titanite corresponds to the mean ambient temperature of ~25°C. This thermodynamically defined limit should be higher under CO_2-rich atmosphere. The presence of authigenic titanite in ancient paleosols formed on Earth and other planets may indicate the hot and wet environmental conditions, low pCO_2, or reduced atmospheric composition.

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