(U-Th)/He and $^{40}Ar/^{39}Ar$ geochronology of weathering, Hamersley Province, Australia: implications for weathering history and landscape evolution

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(U-Th)/He dating of goethite, when combined with quantification of diffusive ^{4}He loss by the $^{4}He/^{3}He$ methodology, provides reliable corrected ages for minerals precipitated in weathering profiles. We have combined (U-Th)/He dating of supergene goethite with $^{40}Ar/^{39}Ar$ dating of supergene manganese oxides to study the weathering history and landscape evolution in the Hamersley Province, northwestern Australia.

Incremental heating $^{40}Ar/^{39}Ar$ analysis of 187 grains of Mn oxides from 65 samples (44 hand specimens) collected from weathering profiles at seven field sites across the Hamersley Province, yield precipitation ages ranging from 63.4 ± 0.9 Ma to 1.5 ± 0.2 Ma. These results, combined with previous results of $^{40}Ar/^{39}Ar$ dating of Mn oxides [1,2], reveal a protracted and episodic history of weathering and landscape evolution, which was already ongoing in Late Cretaceous and spans the Palaeogene and Neogene.

Seventy-three grains of goethite from 39 samples extracted from 21 hand specimens, collected from the same field sites where the Mn oxides originated, were dated by the (U-Th)/He method. Internally consistent (U-Th)/He ages, which range from 84.3 ± 12.2 to 3.3 ± 0.5 Ma, have been obtained for most samples when corrections are applied for 10% helium diffusive loss. The geochronological results obtained show remarkable similarity in the distribution of ages associated with supergene mineral precipitation.

The widespread occurrence of iron oxides such as goethite in soils and weathering profiles and the successful application of (U-Th)/He dating of goethite offers great opportunities for extracting the wealth of palaeoclimatic and palaeoenvironmental information recorded by these profiles on the surface of terrestrial planets such as Earth and Mars.

References

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