

Geochronology of Weathering and Pedogenesis

PAULO M. VASCONCELOS^{1,2,3}

¹The University of Queensland, School of Earth Sciences,
Brisbane, Qld 4072; paulo@earth.uq.edu.au

The combination of ⁴⁰Ar/³⁹Ar, (U-Th)/He, and U-series dating of weathering-product and pedogenic Mn and/or Fe oxyhydroxides permits determining the chronology and rate of chemical reactions in the weathering crust. These methodologies are complementary and suitable for dating processes spanning from Recent to the earliest preserved weathering profiles on Earth. The application of these methods in weathering geochronology reveals that minerals hosted in pedoliths are invariably much younger than minerals preserved in the underlying saproliths, indicating that the pedolith has a much greater propensity to undergo mineral dissolution-reprecipitation than the remainder of the weathering profile. The greater reactivity of the pedolith appears to be controlled by organic activity, mechanical and chemical, which promotes frequent and recurrent mineral dissolution-reprecipitation. In contrast, the underlying saprolith appears to record the influx of weathering solutions during the early stages of evolution of a weathering profile. Once precipitated, saprolith minerals may remain in metastable equilibrium, sometimes for millions or tens-of-millions of years. Saprolith minerals become more prone to dissolve and reprecipitate when the pedolith front advances into the saprolith. But only during drastic changes in weathering conditions do minerals within the saprolith undergo dissolution-reprecipitation. Identifying and dating the multiple generations of supergene minerals in both the pedolith and saprolith reveal a history of weathering that is protracted and episodic, particularly in the case of deep and stratified lateritic weathering profiles. The major challenges in applying these geochronological approaches to the study of weathering and pedogenesis is the difficulty in identifying and physically sampling distinct generations of supergene minerals. This challenge is particularly acute in the pedolith.

Gas discharges for continental Spain: Geochemical and isotopic features

ORLANDO VASELLI^{1,2}, BARBARA NISI³, FRANCO TASSI^{1,2},
TOM DARRAH⁴, JORDI BRUNO⁵, JAVIER ELÍO⁶,
FIDEL GRANDIA⁷ AND LUIS PEREZ DEL VILLAR⁸

¹Department of Earth Sciences, Florence, Italy
(*correspondence: orlando.vaselli@unifi.it)

²CNR-IGG, Institute of Geoscience & Earth Resources
Florence, Italy

³CNR-IGG, Institute of Geoscience & Earth Resources Pisa,
Italy

⁴Division of Earth & Ocean Sciences, Nicholas School for the
Environment, Durham, USA

⁵Amphos21, Barcelona, Spain

⁶Fundación Ciudad de la Energía (CIUDEN), Ponferrada,
Spain

⁷CIEMAT, Unidad de Integración de Sistemas Geológicos
Madrid, Spain

In this work the results of a geochemical and isotopic survey of 37 gas discharges was carried out in continental Spain are presented and discussed. On the basis of the gas chemical composition, four different areas can be distinguished, as follows: 1) Selva-Emborda (SE) region; 2) Guadalentin Valley (GV); 3) Campo de Calatrava (CC) and 3) the inner part of Spain (IS).

The SE, GV and CC areas are characterized by CO₂-rich gases, while IS has N₂ as main gas compound. The CO₂-rich gases can be distinguished at their turn on the basis on the helium and carbon isotopic composition. The SE and CC areas have a strong mantle signature (up to 3 Ra). Nevertheless, the carbon isotopic composition of CC is within the mantle range and that of SE is slightly more negative (down to -8‰ PDB). The GV gases have a lower mantle signature (≈1 Ra) with respect to SE and CC and more negative carbon isotopes (≈-10‰ PDB). It is worth to mention that the SE, GV and CC areas are related to the youngest volcanic activity in continental Spain, for example the Garrotxa Volcanic Field in Catalonia records the latest event dated at 10,000 years, and the isotopic features, particularly those of helium, are suggesting the presence of magmatic bodies still cooling at depth. The N₂-rich gases, i.e. those from the IS area, has an atmospheric origin, as highlighted by the N₂/Ar ratio that ranges between those of air and ASW (Air Saturated Water). The isotopic composition of carbon is distinctly negative (down to -21‰ PDB) and that of helium is typically crustal (0.02-0.08 Ra), confirming that these gas discharges are related to a relatively shallow source.