The production and retention of mineral nutrients in soils of the karst critical zone of southwest China

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Karst landscapes, created through weathering of carbonate bedrock, host ecosystems that are extremely sensitive to human activity. Catastrophic loss of ecosystem function can result from unsustainable use of karst landscapes because they are particularly vulnerable to soil degradation by erosion and desertification. Karst is widespread in southern China where intensification of food production through agriculture during the 20th century has led to a rapid deterioration of the karst critical zone with significant loss of soil and reduced crop production. Soil degradation not only puts delivery of food provision at risk but also the potential for recovery of ecosystem services delivered in the natural state, even if agriculture is halted. However, little is known about the geological, hydrological and ecological processes that control soil fertility and soil function in karst landscapes and how best to manage them to protect and maximise ecosystem services.

As carbonate rock dissolves completely upon weathering, the production of soil nutrients in karst landscapes may be strongly dependent on weathering of beds of silicate rock and carbonate beds with silicate impurities within the dominant limestone and dolomite bedrock (Ji et al. 2004).

This studentship will investigate the production of soil nutrients by weathering processes in an agricultural karst critical zone observatory in Guizhou province, China, as part of the SPECTRA project. The student will analyse mineral nutrient profiles in bulk soils and soil pore waters as functions of lithology and land use. Mineral nutrient fluxes over the time scale of soil development (long-term) will be derived from the elemental chemistry of bulk soil profiles, whilst fluxes over the time scale of water infiltration (short-term) will be derived from the chemistry of pore water profiles (White 2002). The student will use these data together with data on physical and chemical erosion gathered by other SPECTRA team members, to build reactive transport models of karst critical zone soil formation, which will then be used to investigate mineral nutrient production under different land management scenarios.

*Figure 1. The karst landscape of Chenqi catchment, Guizhou Province, China, in the SPECTRA Karst Critical Zone Observatory. See: [http://geography.exeter.ac.uk/spectra/about/](http://geography.exeter.ac.uk/spectra/about/) for more about the SPECTRA project.*
The student will form part of an international team of UK and Chinese scientists as part of the recently funded (Newton fund via NERC and the National Science Foundation of China) project SPECTRA: Soil Processes and Ecological Services in the Karst Critical Zone of Southwest China. The overarching scientific objective of SPECTRA is to determine 1) what controls the resilience, response and recovery of the critical zone and its integrated geophysical-geochemical-ecological functions to perturbations, and 2) how understanding of interactions between CZ processes, from molecular to catchment scale, can be integrated to develop sustainable landscape management plans.

The student will be immediately integrated into the UK SPECTRA team such that s/he will attend regular meetings with team members (from the Universities of Exeter and Bristol and from Rothamsted Research). The student will also meet and interact with visiting postdoctoral researchers from the Chinese team of the SPECTRA project and interact with the global Critical Zone Observatory (CZO) networks (e.g., [www.criticalzone.org]).

![Figure 2](image)

Figure 2. a) Soil-scale (after Maher et al. 2009) and b) interface-scale (Buss, unpub.) K-feldspar weathering profiles generated from data (●) or reactive transport models (--) at different partial pressures of CO₂. Profiles such as these enable determination of rates of mineral nutrient fluxes and how they may respond to environmental changes such as land use or climate change.

