U(VI) and Eu(III) interaction with pyrite (FeS_2)

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The mechanism of U(VI) and Eu(III) interaction with pyrite was studied by solution chemistry and X-Ray Photoelectron Spectroscopy (XPS). Pyrite dissolution under anoxic conditions leads to the production of sulphoxyanions and ferrous iron, which in turn is sorbed at the pyrite surface. This sorption was confirmed by isotopic dilution. U(VI) is in competition with Fe(II) for adsorption on sulfur sites. This sorption is maximum at pH ≥ 5.5. Co(II) and Eu(III) are also sorbed on pyrite surface at pH ≥ 5.5, confirming that sorption on pyrite does not necessarily result from a redox reaction.

When $[U]_{sorbed}$ is below 4 10^{-9} mol g^{-1}, a redox reaction occurs at the pyrite surface and leads to the formation of reduced uranium and elementary sulphur. Iron remains at oxidation degree +II during the whole process. The formation of these solid products tends to passivate the pyrite surface as the redox reaction is no longer observed when the amount of sorbed U increases. The surface is saturated for $[U]_{sorbed}$ = (3.4±0.8) 10^{-7} mol L^{-1}. The sorption at [U] > 10^{-9} mol L^{-1} can be modelled by a Langmuir isotherm with a sorption constant equal to 8 10^{7} L mol^{-1}.

At higher uranium (VI) concentration, a redox reaction between U(VI) and Fe(II) occurs. This reaction produces a U(IV)-U(IV) mixed (hydr)oxide, $U_4O_{9(s)}$, and iron (III) (hydr)oxide, such as maghemite (γ-$Fe_2O_{3(s)}$), which can in turn participate to U(VI) adsorption.

Comparison of estimates for Andean Plateau formation from thermochronology and stable isotope paleoaltimetry

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Quantifying the timing and rates of central Andean mountain building and plateau formation have previously been limited by (1) sparsely available age constraints on the timing of deformation, and (2) a lack of constraints on the elevation history of the plateau. We address these limitations with 52 new low-temperature thermochronometer ages, and stable isotope paleoaltimetry results of Garzione *et al* (2005) and Ghosh *et al*. (2006). Thermochronometer samples were collected across two 200-300 km long transects in the northern (~15ºS) and southern (~19ºS) Bolivia thrust belt. We assess the consistency of interpretations of plateau formation from these two approaches.

We interpreted thermochronometer cooling ages along each transect to constrain the timing of deformation in different tectonic zones across the Andes. Results suggest a consistent chronology of deformation in northern and southern Bolivia. We find: (1) deformation initiated ~40 Ma along the plateau margin (Eastern Cordillera) with distributed exhumation across the entire thrust belt since about ~15 Ma, (2) deformation in the eastern part of the thrust belt (Subandean Zone) initiated by ~25-10 Ma, (3) shortening rates across each transect have been similar and decelerated over the last ~20 Ma, and (4) development of the Andean Plateau analogous to it's modern width (but unknown elevation) occurred by ~20 Ma (Barnes *et al*., 2006).

In comparison, paleoaltimetry results suggest a 3.7 ± 0.4 km increase in plateau elevation between 10.3-6.7 Ma. Plateau rise is suggested to have increased deformation in the Subandean Zone over this time interval. The retention of a dense mantle root below the plateau could account for the plateau remaining at a low elevation for ~10 Ma after the thermochronometer data suggest its modern width formed. However, the steadiness of shortening rates across the thrust belt since ~20 Ma, as well as the initiation of Subandean deformation predating plateau rise by up to ~10 Ma draws into the question the consistency of these two approaches. Work in progress is evaluating if temporal variations in atmospheric temperature and moisture source could account for the appearance of a low-elevation plateau prior to 10.3 Ma from stable isotope techniques.

References

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