Petrology of the crystalline rocks hosting the Santa Fe impact structure

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The Santa Fe impact structure was recently identified by the presence of shatter cones in the Proterozoic crystalline rocks of the Sangre de Cristo Mountains of northern New Mexico [1]. The rocks are deeply eroded and tectonized and no crater morphology is preserved, but the original crater is estimated to have been 6-13 km in diameter [2]. The Greenvillian regional uplift of ~1200-900 Ma [3] provides an upper bound for the age of the impact, because only afterwards would the crystalline rocks be under the brittle crustal regime necessary for shatter cone formation and preservation [2].

Preliminary $^{40}Ar/^{39}Ar$ analysis of K-feldspar separates from a shatter cone-hosting rock and from gneiss outside of the presumed impact area show ~1000 Ma and 400-450 Ma events consistent with regional geology [3]. However, the shatter cone lithology shows a complex Ar diffusion pattern that is not easily interpretable. In an attempt to resolve this, we have collected samples from within the area of shatter cone occurrence and for ~8 kilometers (map distance) along the roadway, with which we are constructing a detailed petrologic map. This will help us to better understand the relationships among rocks in the area and their possible responses to the impact event, and these data will aid in the interpretation of Ar diffusion and dates.

[1] McElvain, Read, Petersen, Elston, Newsom & Cohen (2006) *GSA Abstracts with Programs* **38**(7), 298. [2] Fackelman, Morrow, Koeberl & McElvain (2008) *Earth Planet. Sci. Lett.* **270**, 290–299. [3] Sanders, Heizler & Goodwin (2006) *GSA Bull.* **118**(11–12), 1489–1506.

Evidence of iron isotope fractionation due to biologic lifting in a soil chronosequence

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Iron (Fe) distribution versus landform exposure time was quantified in a marine terrace chronosequence northwest of Santa Cruz, California. The abundance of soil Fe increases with terrace age on the five terraces studied (65 to 226 Ka). Mass change calculations for Fe indicate that Fe is concentrated near the surface, and also depleted at depths >1.5m. The mass of Fe in surficial soil (0-1.5m) cannot be fully accounted for by weathering, compaction of the soil profile and the addition of Fe from eolian sources. Terrace regoliths are generally unsaturated and aerobic [1] making, lateral movement of the requisite amount of dissolved iron (in reduced form) unlikely.

Iron is a plant micronutrient; and unlike other mineral nutrients, it is relatively insoluble in aerobic soil solutions. We propose that plant roots and associated symbiotic fungi (mycorrhizae) transported Fe from the underlying regolith to shallow soil through biolifting. Once plant bound Fe is released from decaying organic matter, the Fe forms oxides that are incorporated into the shallow soil. To evaluate this hypothesis, the Fe content of current grassland vegetation was determined and yearly biomass Fe uptake calculated. Results showed that the yearly cycling of plant-utilized Fe in above ground biomass multiplied by the age of the terrace is roughly equivalent to the shallow iron content of these soils.

Plants that use the strategy I acquisition process preferentially incorporate isotopically light Fe up into their tissues [2]. Therefore, biolifting should concentrate light Fe in shallow soils. Further supporting the biolifting hypothesis, Fe isotope ratios for shallow bulk soil samples were found to have lighter Fe with increasing terrace age. The $\delta^{56/54}Fe$ values at 10cm soil depth from the youngest to oldest soil are: 0.55, 0.63 0.38 and 0.18. Deep soil samples (>3 m) have a relatively constant isotopic composition with $\delta^{56/54}Fe$ ranging from 0.60 to 0.68. These ratios are within the range of values for the sediment source rocks. The terrace ecosystem is currently dominated by grasses that utilize the strategy II Fe uptake process which does not significantly fractionate Fe [2] Thus, the Fe isotope composition of these soils suggests that forest or chaparral ecosystems existed on the terraces prior to the present grassland.

[1] White *et al.* (2009) *GCA* **73**, 2769–2803 [2] Guelke & Von Blankenburg (2007) *ES&T* **41**, 1896–1901.