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Exploring for Vertebrate Fossils in the Riversleigh Area of Queensland using Field-Portable XRF

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Cenozoic limestone units within the Riversleigh World Heritage Area, Queensland, host a large array of Oligocene to Pleistocene vertebrates, invertebrates and plants [1,2]. The most productive fossil locations within the 100km^2 of limestone outcrop are the cave deposits developed within (freshwater) Cenozoic and (marine) Cambrian limestones [3]. Since the early 1970s, exploration techniques for fossil deposits has largely been limited to observation of bone or tooth fragments on weathered surfaces, or the presence of materials such as flowstones and stalactites / stalagmites. More recent work has been conducted determining whether there are geochemical indicators of potentially fossil-bearing limestone based on detection of either fine-grained bone fragments or trace elements associated with appropriate limestone facies, by *in situ* multi-element geochemical analysis of outcrop using field-portable XRF (Fig. 1).

Figure 1: Analysis of vertebrate fossil-bearing limestone using fpXRF.

There are a number of geochemical indicators that allow differentiation of Cambrian from Cenozoic limestones, including the Sr/Ca, Mn/Fe and Zn/Ca ratios, reflecting different depositional environments and possibly the influence of base metal-mineralised Proterozoic basement units. Analysis of bone fragments from Riversleigh fossils indicate elevated Zn (>150ppm) and U (>20 ppm), with the highest levels of trace elements typically found in bat skulls. Where P concentrations are elevated (but where there are no visible bone fragments) U, Zn and Sr are the best discriminators in the rocks to indicate the presence of bone or tooth material, as well as secondary phosphates.

Most of the bone deposits are found within in-filled caves containing a mixture of re-precipitated calcite and detrital material. Hence, there are additional geochemical indicators of potentially bone-bearing depositional environments including a close association between Fe-Pb-Zr-Ti-Mn-REE, as well as various ratios including Si/Ca.

References:

[1] Archer M et al. (1989) Aust Zool 25: 29–66
[2] Hand SJ and Archer M (2005) Palaeontology 48:371–383.
[3] Woodhead J et al. (2015) Gondwana Res