Nd isotopes as indicator of glacio-eustasy, mid-Carboniferous boundary Arrow Canyon, NV

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To better understand the effect of large-scale glaciation and sea level change on circulation in the epicontinental sea of western North America, we have generated a record of Nd isotopes spanning the mid-Carboniferous boundary using fossil apatite extracted from carbonate rocks collected in Arrow Canyon, Nevada. During the Carboniferous the Arrow Canyon lay near the equator within a foreland basin flooded by the North American epicontinental seaway. This region accumulated a thick, nearly continuous sequence of shallow marine sediments now recognized as the Mississippian-Pennsylvanian GSSP [1]. However, sedimentological studies reveal a number of brief depositional hiatuses when the region experienced subaerial weathering and/or soil development [1, 2, 3, 4]. The $^{143}Nd/^{144}Nd$ isotopic signature of marine waters is controlled by weathering inputs from old crustal rocks (unradiogenic Nd) and young volcanic rocks (radiogenic Nd). Carboniferous $^{143}Nd/^{144}Nd$ values (expressed in epsilon notation and corrected for age, $\varepsilon Nd_{(t)}$) for the open ocean (Panathalassa/Rheic) were relatively radiogenic, -5 to –6, based on analysis of biogenic apatite in shallow marine rocks from Patlanoaya, Mexico, which was a small detached block moving northward from Gondwana during the Mississippian. We measured $\varepsilon Nd_{(t)}$ values of approximately –7.6 for Arrow Canyon samples of mid-late Chesterian age suggesting that at this time a strong connection existed between the region and the open ocean. Upsection, $\varepsilon Nd_{(t)}$ decreases to –9.4 in limestone topped by a paleokarst surface 2.5 m below the mid-Carboniferous (Chesterian-Morrowan) boundary [3], then increases back to ~7.6 across the flooding surface (identified by [2]). A similar decrease in $\varepsilon Nd_{(t)}$, to –10.1, was measured about 3 m above in fossils extracted from a limestone bed directly overlying a green-brown shale containing root traces [3]. The decrease in Nd isotopic values near these exposure surfaces implies that circulation between the epicontinental seaway and open ocean became restricted as sea level fell. Enhanced contributions of water from interior basins of the mid-continent are the most likely source of the unradiogenic Nd.

[1] Lane *et al*. (1999) *Episodes* **22**, 272–283. [2] Bishop *et al*. (2009) *Palaeogeogr Palaeocl* **276**, 217–243. [3] Barnett & Wright (2008) *J Geol Soc London* **165**, 859–873. [4] Richards *et al*. (2001) in *Carboniferous & Permian of the World*, p.802.

Advantages of combining geochronologic and trace element analyses using the SHRIMP-RG

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The combined high mass resolution and transmission of the SHRIMP-RG allows trace element determinations to be made without energy filtering. Standard U-Th-Pb analyses can be combined with trace element analyses by operation at 8000 MR (10% peak height). Acquisition tables for U-Th-Pb geochronology for zircon, titanite, and monazite routinely cover the mass range from 89 (Y) to 254 (UO) providing REE and other trace element data for each spot for which an age is determined and adding only an extra two minutes to the analysis time. More complete trace element analyses (Li to UO), done separately from geo- chronology, provide additional data, and can be invaluable in pre-screening individual grains and zones in grains for age analysis (U-Th-Pb and U-Th). In the last 4 years a large dataset has been developed for suites of zircons (smaller datasets for titanite and monazite) from samples representing diverse compositions and environments of formation. As a result of strong compositional zoning in individual grains and suites of grains the compositional data are most useful for understanding igneous and metamorphic processes and not for determining rock type. Some compositional characteristics are useful for fingerprinting MORB vs. continental, or crustal vs. lithospheric regions, or identifying specific sources. Divergence in established compositional trends can help confirm that a mineral suite is of mixed source and/or age which is increasingly important given the recognition of the common occurrence of inherited and antecrystic grains. Mineral thermometers for igneous zircon and titanite and the application of partition coefficients to compositional data allow the monitoring of melt composition and temperature during mineral growth. Age, temperature, and the specific minerals involved in metamorphic reactions (esp. garnet, feldspar) can be determined for zircon, monazite and titanite. Age and compositional data for inherited zircons can provide otherwise unobtainable information about the middle and lower crust.