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Reconstructing the cosmogenic 21Ne inventory of Neogene sedimentary sequences

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The cosmogenic radionuclides, in particular 10Be, have found use in modern sediments as a way of determining the erosion rate of river catchments. Cosmogenic 21Ne in quartz is easier and faster to measure than 10Be and has the potential to record erosion rates back 10s million years. However the routine use of cosmogenic 21Ne in quartz sand is hampered by ubiquitous nucleogenic 21Ne. When the eroding lithology can be identified it is possible to measure the nucleogenic in samples that are shielded from cosmic rays and correct for it in exposed bedrock [1]. However, identifying the lithologies that contributes quartz sand in large river catchments, and determining precise nucleogenic contributions is more problematic.

The North and South Platte rivers drain early Prototerozoic lithologies of the Laramie and Front Ranges in the high Rockies of Wyoming. They have deposited several km of coarse clastic fluvial deposits on the Great Plains of Nebraska and Colorado up to 200 km from the mountain front. Quartz from shielded samples of granite and gneiss - the dominant quartz-bearing rocks - has high concentrations of nucleogenic 21Ne (60-140 e6 atoms/g). The 21Ne concentration in modern sand from the river (n=10) overlaps that measured in the shielded granite and gneiss. The sand data rarely lie on the air-spallation mixing line in the Ne three isotope plot indicating that it is dominantly derived from the granite and gneiss and has no resolvable cosmogenic 21Ne.

Building on previous studies of cosmogenic 21Ne in pebbles [2] we have started a programme of analysis of pebbles derived from the Medicine Bow quartzite that are abundant throughout the Cenozoic alluvial sequence. Nucleogenic 21Ne in shielded quartzite is lower than granites (3-7 e6 atoms/g, n=4) and the data tend to lie on the air-spallation mixing line. All pebbles (n=14) from modern sediments analysed so far contain 2-80 times more excess 21Ne than the highest shielded quartzite suggesting that cosmogenic 21Ne is ubiquitous. The data require minimum average pebble transport times of 150 kyr. A similar distribution of cosmogenic Ne concentrations is present in quartzite pebbles from gravels from the Pliocene Broadwater Formation and Miocene Ogallala Formation gravels indicates that the rates of transport and pebble recycling on flood plain have not changed over the Neogene.

[1] Margerison et al. (2005) Earth Planet. Sci. Lett. 230, 163-175.
[2] Codilean et al. (2008) Geology 36, 159-162.