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Cosmogenic Be-10 in fine-grained quartz from shale

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In situ-produced Be-10 is routinely used in the mineral quartz for measuring exposure times and erosion rates. Most previous applications have focused on relatively coarse mineral grains (typically greater than 100 microns) in sandstone, quartz veins, or igneous and metamorphic rocks. Here we report Be-10 measurements from fine-grained quartz extracted from shale bedrock and sediment. Shale typically contains 25% or more quartz, but because it is fine-grained it has been considered difficult to purify. Quartz grains less than 10 microns in size are also subject to ejection and implantation of Be-10 during the production reactions, creating potential complications.

We purify quartz from shale using hot phosphoric acid after combustion of organics and dissolution of clays in hot sodium hydroxide. Centrifugation of the fine-grained minerals after each step rapidly settles the micron-sized quartz. Heavy minerals are separated by centrifugation in lithium heteropolytungstate. We have obtained pure quartz for size fractions ranging from 1-100 microns. Preliminary results suggest that grains finer than 5 microns may contain meteoric Be-10; experiments are underway to identify the source of this contamination.

We have conducted field experiments in the layered rocks of the southern Appalachian Mountains, USA, where mountain ridges are held up by resistant sandstone while valleys are typically underlain by shale and limestone. Our initial results in Shenandoah Valley indicate that shale in the valley floor has a denudation rate similar to the long-term rate of river incision, while previous research shows that sandstone ridges are eroding much more slowly. Our results suggest that mountain relief is growing in this region due to lowering of the shale- and limestone-floored valleys.

Student Submission

No

Primary authors: GRANGER, Darryl (Purdue University); HUANG, Xianmei (Purdue University); Dr ODOM, William (USGS); BRODY, Conner

Presenter: GRANGER, Darryl (Purdue University)

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