Combining spot samples and continuous sampling to study small catchment storm runoff

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We have used two different sampling techniques to study the geochemical response of a small lowland rural catchment to episodic storm run off. The first method involves traditional daily spot sampling and has been used to develop a standard end member mixing analysis (EMMA) of the relative contributions of ground water flow and surface run off to the total stream flow. The second method utilises a continuous sampling device, powered by an osmotic pump, to produce an integrated 24-hour sample of the stream flow.

There is generally very good agreement between the patterns of solute chemistry measured from both sampling methods. The spot sample data can be used to construct a hydrograph separation model for the river chemistry that indicates the export chemistry is dominated by groundwater flow during low flow conditions and surface runoff during high flow conditions, but that the groundwater flux also increased during periods of high flow. Comparison between the chemistry predicted from the hydrograph separation model and the concentrations recorded by the continuous sampler are generally very good for most solutes. For NO_3, however, data from the continuous sampler indicates that there is a stored soil water reservoir that contains high NO_3 concentrations and is flushed during the rising hydrograph limb of a storm event. The continuous sampler data also indicates that the NO_3 concentration of this reservoir takes >7 days before it is replenished to pre-flushing event levels. Combined use of spot sample and continuous sample data can yield insights into the behaviour of nitrate during storm events, that are not apparent from spot sample data alone.

The elasticity of hydrous minerals in the lower mantle

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Water is recycled into the Earth's interior by hydrous minerals in descending slabs and the amount of water that is transported into the deep mantle depends on the stability of high-pressure hydrous phases. As water plays an important role in mantle dynamics and planetary evolution, the study of the structure, elastic properties and stability of possible hydrous high-pressure phases in subducting slabs is of crucial importance.

A number of hydrous phases have been experimentally synthesized at pressures and temperatures compatible with subduction zone conditions. Very recently, a super aluminous version of the dense hydrous magnesium phase D (Al-phase D), was synthesized in a simplified basaltic bulk composition at lower mantle conditions [1]. The high temperature stability of this new form of phase D, which is stable up to 1600°C at 26 GPa, suggests that this phase may be an important host for water within portions of subducted oceanic crust in the Earth's lower mantle. Given the importance of such a hydrous aluminous phase and the fact that no similar phases have been previously reported, we investigated its elasticity.

High-pressure single crystal X-ray diffraction measurements were performed using a diamond anvil cell. Simultaneously S and P elastic wave velocities were measured using Brillouin spectroscopy. Preliminary results indicate that although Al-phase D can contain up to 16 wt% H_2O, the measured Vs and Vp are similar to that expected for an anhydrous lower mantle assemblage. Consequently if larger amounts of H_2O were present in this phase within the lower mantle it would have an undetectable seismic signature.

[1] Boffa Ballaran *et al*. (2010) *Am. Mineral*. **95**, 1113–1116.