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35,000 years of hydrological variability in northern New Zealand from speleothem magnetism

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Speleothem magnetism is the study of the origin and geo-enviromagnetic significance of magnetic minerals in speleothems. Allogenic magnetic particles are transported to speleothem sites from soils and sediments by hydrological and aeolian processes. The two main hydrologic transport mechanisms are infiltration through karst porosity and entrainment in fluvial transport. Cave ventilation constitutes a third input mechanism, supplying aeolian particulate matter. Water percolating from the surface tends to discriminate towards smaller, pedogenic magnetic mineral grains, whereas fluvial and aeolian processes discriminate towards larger, non-pedogenic (lithogenic) grains. If magnetic populations in speleothem calcite samples can be thoroughly characterised, individual components can be recognised which relate to specific processes of transport, and the contributions of these components can be used to reconstruct variability in the strength of these processes over the depositional period of the speleothem.

We used magnetic first-order reversal curve diagrams to characterise the magnetic fraction of a flowstone from Waipuna Cave, western North Island, New Zealand. The U/Th dated flowstone covers the last 35 kyr. We found two main magnetic components: a coarse-grained (micrometres to tens of micrometres) magnetite component present in high concentrations, and a fine-grained (tens to hundreds of nanometres, or submicrometre) magnetite component in low concentrations. We relate these to lithogenic and pedogenic magnetite (respectively) found in the soils overlying the cave. We hypothesise that the (coarse-grained) lithogenic component represents a flooding signal and the (fine-grained) pedogenic component represents magnetite transport by drip water. The magnetic signal of the Waipuna flowstone thus has the potential to provide information on variability in two aspects of the hydrological cycle over the last 35 kyr.