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Search for a geomagnetic signal produced by the movement of groundwater in fractured carbonate rocks

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It is known that the groundwater circulation within the Earth's crust will contribute to fluctuations in the geomagnetic field due to currents generated by the electrokinetic effect at the rock-water interface. In principle this offers a new way to study the flow of water through rock, and identify the origin of self-potential anomalies. However these signals are masked by the much larger fluctuations due to ionospheric currents. We have carried out an experimental search for a magnetic signal correlated with groundwater flow in fractured carbonate rocks, by taking simultaneous measurements with two SQUID magnetometers. This was done at the low background noise interdisciplinary underground research laboratory in Rustrel (LSBB, France). There, a network of artificial tunnels arbitrarily intersects tectonics and karstified features in depth of a typical Cretaceous karstified carbonate platform. Groundwater drains through some of these features. Where the tunnel cuts a water flow, the rate of flow is monitored. The background geomagnetic fluctuations were monitored using the [SQUID]2 (SQUID with Shielding QUalified for Ionosphere Detection) magnetometer, situated in a shielded cell beneath 518m of karstic rock. A second 3-axis SQUID magnetometer was set up at a point of monitored water flow in a tunnel 363m below the surface. From data taken over a period of several weeks, we set the first limit on the magnitude of such a magnetic signal.