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Time lapse electric resistivity tomography to portray water infiltration and hydrologic flow paths above Golgotha Cave, Western Australia

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Golgotha Cave, in the south west of Western Australia, is an intensively studied cave which provides a rare but rich geoarchive in the form of stalagmites. The area is known for its wet winters and dry summers, producing a Mediterranean climate. Stalagmites can contain high-resolution paleoclimate archives, something that is rare in this Mediterranean location. To resolve and interpret the climate signal contained in the stalagmite geochemistry at the cave, long-term hydrological, geochemical and climate monitoring has been undertaken in the two main cave chambers. However, despite the close proximity of a few decametres between the two chambers, their hydro-chemical signal differs in composition and quantity. A theoretical model was developed which included the possibility of preferential flow through pipes created by endemic Karri trees.
Here we show the results of a 1.5 year monitoring program above the cave using time-lapse electric resistivity tomography (TL-ERT). Between May 2016 and January 2018 several 200m long lines were monitored using a 100 multi-electrode Lipmann 4point light instrument. Various Wenner and Dipole-Dipole arrays provided information of electric resistivity changes throughout the year. Small scale laboratory experiments generated electric resistivity to volumetric water content curves for different soil and rock materials. The change in resistivity was dominantly linked to moisture changes and interpreted as the annual infiltration pattern. It furthermore showed a moist and strongly karstified subsurface area which very likely acts as an up to date unknown water storages throughout the year. Individual solution pipes could not be discovered with our method but an area where water quickly infiltrates vertically is assumed to be influenced by multiple solution pipes. The study shows the great potential of TL-ERT in assessing hydrologic patterns in karst areas.