Electrical Resistivity Imaging of Groundwater Convection in the Nacimiento Fault
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Abstract
Theory exists for unstable convective motion in porous and fractured media, and has been detected in porous media in the field. Groundwater convective theory is limited due to a lack of field evidence to understand the process of free convection in other settings such as faults. The Nacimiento Fault Zone in New Mexico was a suitable location for such a field study. This work provides quantification of thermohaline convection in a hydraulically active fault zone. The hypothesis proposed that measured convective parameters of wavelength and timescales obtained from Electrical Resistivity Imaging (ERI) and fluid data will correlate to convective groundwater theory in fault zones. Over a two year period (2011-2012), 16 ERI lines were provided two and three dimensional mapping of the convective fluid signatures of the Nacimiento Fault. Additionally, 1 line of transient data evaluated changes in the fault over a 6 day timescale. The results show circulate conductive features which change over time as well as strong EC changes in transducer data.

Problem
Convective theory exists in porous and fractured media, and the detection of natural convection in porous media has been recently explored, however it has never been proven in a field setting in fractured media. This research provides the first attempt to quantify thermohaline convection in a hydraulically active fault zone. The hypothesis maintains that measured convective parameters of wavelength and timescales obtained through the use of geoelectric and fluid data, will be consistent with convective groundwater theory in fault zones.

Methodology
A total of ten 550 meter long ERI lines were plotted using GPS data and surveyed over a timescale of one week. ERI cables were connected to metallic stakes driven into the travertine/soil through electrodes located every 10 meters. The data were collected through the use of an AGI SuperSting R8 multi-channel portable earth resistivity meter and later processed through the use of resistivity inversion software. Two and Three dimensional images were created from the resistivity data collected at the site.

Results
- Wavelength analysis demonstrates cells have a significant signal-to-noise in the analysis (based on the Rose Criterion) with 196 meter mode 1 cells and 121 meter mode 2A cells.
- Repeatability among the images collected in summer of 2011 and summer 2012 orthogonal to the fault showing 2 highly conductive circular features with antithetical features.
- Transient features observed in conductivity in both ER data and transducer data from springs.

Conclusions
- The primary purpose of the research was to provide the first quantification of thermohaline convection in a hydraulically active fault zone. Mode 1 and Mode 2A cells are quantified.
- Convective parameters of wavelength and timescales were consistent with convective theory.
- Alternative explanations of the data are eliminated by one or more features of the dataset.

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