與猶他州亨利山粗面岩台地侵入體相關的變形條帶分析：對儲層連通性和岩床侵入體周圍流體流動的影響

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摘要

淺層火成岩入侵是許多沉積盆地的共同特徵，人們越來越認識到母岩中的同位變形結構有助於適應這種岩漿的增加。然而，人們對火成岩侵入的次震結構和儲層規模的影響仍然知之甚少。粗面岩台地侵入體是猶他州亨利山脈漸新世希爾勒斯山侵入體的一個小型（～ 1.5 km^2）、東北-西南走向的衛星侵入體。它位於高度多孔的風成恩特拉達砂岩層（侏羅紀）內，產生了一個由東北-西南走向的顯著變形條帶組成的共軛網絡，其趨勢與侵入邊緣平行。透過定義一系列節點和分支來表徵網絡，由此確定變形條帶跡線和分支的拓撲、頻率、強度、間距、特徵長度和無量綱強度。這些定量的幾何和拓撲測量得到了岩石學、孔隙率和微觀構造分析的補充。結果表明，隨著越來越接近侵入體，變形條帶強度顯著增加，孔隙率顯著降低，變形條帶可能會阻礙流體流動，在恩特拉達儲層單元內形成屏障和阻擋。Y 和 X 節點的增加凸顯了變形條帶連通性的顯著增加，這反過來將顯著降低砂岩的滲透率。這項研究表明，火成岩侵入體周圍變形圍岩中的流體流動可能與未變形圍岩中的流體流動有顯著差異。更了解變形結構的可變性及其與侵入幾何形狀的關聯，將對天然裂縫儲層內的流體流動增加價值（例如碳氫化合物儲層產能、水文、地熱能和碳封存）的產業產生重要影響。

關鍵字： 同位變形結構、變形條帶、孔隙率、滲透率。

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Solid Earth Discussions

Analysis of deformation bands associated with the Trachyte Mesa intrusion, Henry Mountains, Utah: implications for reservoir connectivity and fluid flow around sill intrusions

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Abstract. Shallow-level igneous intrusions are a common feature of many sedimentary basins, and there is increased recognition of the syn-emplacement deformation structures in the host rock that help to accommodate this magma addition. However, the sub-seismic structure and reservoir-scale implications of igneous intrusions remain poorly understood. The Trachyte Mesa intrusion is a small (~1.5 km^2), NE–SW trending satellite intrusion to the Oligocene-age Mount Hillers intrusive complex in the Henry Mountains, Utah. It is emplaced within the highly porous, aeolian Entrada Sandstone Formation (Jurassic), producing a network of conjugate sets of NE–SW striking deformation bands trending parallel to the intrusion margins. The network was characterized by defining a series of nodes and branches, from which the topology, frequency, intensity, spacing, characteristic length, and dimensionless intensity of the deformation band traces and branches were determined. These quantitative geometric and topological measures were supplemented by petrological, porosity and microstructural analyses. Results show a marked increase in deformation band intensity and significant porosity reduction with increasing proximity to the intrusion. The deformation bands are likely to impede fluid flow, forming barriers and baffles within the Entrada reservoir unit. A corresponding increase in Y- and X- nodes highlights the significant increase in deformation band connectivity, which in turn will significantly reduce the permeability of the sandstone. This study indicates that fluid flow in deformed host rocks around igneous bodies may vary significantly from that in the undeformed host rock. A better understanding of the variability of deformation structures, and their association with intrusion geometry, will have important implications for industries where fluid flow within naturally fractured reservoirs adds value (e.g. hydrocarbon reservoir deliverability, hydrology, geothermal energy and carbon sequestration).