Direct Measurement of Salt Tectonics by InSAR

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The Needles District in Canyonlands National Park, Utah, is known for its well-exposed array of extensional faults, which are thought to be produced by gravity-driven extension and downward flexure of a thin sandstone plate into the Colorado River canyon in response to dissolution and flow of underlying evaporites (halite and gypsum). Due to a lack of precise geodetic data, however, it remains uncertain if and to what extent those extensional faults are currently deforming. In this study we use synthetic aperture radar (SAR) data to search for ongoing, decadal ground displacements, by applying both a stacking interferometric SAR (InSAR) analysis and Interferometric Point Target Analysis (IPTA). Our results show that most of the Needles District is indeed undergoing deformation now at a maximum rate of 2–3 mm/year away from the satellite, looking roughly westward with an incidence angle of about 20 degrees. Also, we identify a localized region along the riverbank that is uplifting at a rate of 2–3 mm/year. We estimate the measurement precision to be better than 0.8 mm/year, except along the riverbank where the errors are probably higher than this, by analyzing residual signals and carrying out a signal recovery experiment using synthetic two dimensional correlated noise. The deforming region is almost totally bounded by the Colorado River canyon to the west and north, a rapidly subsiding, east-west trending graben to the south, and a relatively sharp to very diffuse deformation gradient to the east. We observe deformation patterns that were previously undetected. These include an area in the southwestern part of the deforming region, that is deforming at higher rates than anywhere else in the Needles but that has little surface extensional faulting. Rates of deformation are lower but still clearly significant further north, in a region of spectacularly exposed fault blocks that have been previously studied in considerable detail.