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RESEARCH ARTICLE | JANUARY 01, 2002

The lowest place on Earth is subsiding—An InSAR (interferometric synthetic aperture radar) perspective

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GSA Bulletin (2002) 114 (1): 12-23.

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https://doi.org/10.1130/0016-7606(2002)114<0012:TLPOEI>2.0.CO;2

Article history

Abstract

Since the early 1990s, sinkholes and wide, shallow subsidence features (WSSFs) have become major problems along the Dead Sea shores in Israel and Jordan. Sinkholes are readily observed in the field, but their locations and timing are unpredictable. WSSFs are often difficult to observe in the field. However, once identified, they delineate zones of instability and increasing hazard. In this study we identify, characterize, and measure rates of subsidence along the Dead Sea shores by the interferometric synthetic aperture radar (InSAR) technique. We analyze 16 SAR scenes acquired during the years 1992 to 1999 by the European Remote Sensing ERS-1 and ERS- 2 satellites. The interferograms span periods of between 2 and 71 months. WSSFs are observed in the Lisan Peninsula and along the Dead Sea shores, in a variety of appearances, including circular and elongate coastal depressions (a few hundred meters to a few kilometers in length), depressions in ancient alluvial fans, and depressions along salt-diapir margins. Phase differences measured in our interferograms correspond to subsidence rates generally in the range of 0–20 mm/yr within the studied period, with exceptional high rates that exceed 60 mm/yr in two specific regions. During the study period, the level of the Dead Sea and of the associated ground water has dropped by ?6 m. This water-level drop within an aquifer overlying fine-grained, marly layers, would be expected to have caused aquifer-system consolidation, resulting in gradual subsidence. Comparison of our InSAR observations with calculations of the expected consolidation shows that in areas where marl layers are known to compose part of the upper 30 m of the profile, estimated consolidation settlements are of the order of the measured subsidence. Our observations also show that in certain locations, subsidence appears to be structurally controlled by faults, seaward landslides, and salt domes. Gradual subsidence is unlikely to be directly related to the sinkholes, excluding the use of the WSSFs features as predictable precursors to sinkhole formation.

GeoRef Subject

Asia ground water marl Middle East sedimentary rocks Dead Sea Israel clastic rocks land subsidence foundations

Index Terms/Descriptors

Asia clastic rocks consolidation Dead Sea foundations geologic hazards ground water InSAR interferometry Israel land subsidence levels marl measurement Middle East radar methods rates SAR sedimentary rocks settlement sinkholes solution features structural controls subsidence Lisan Peninsula

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