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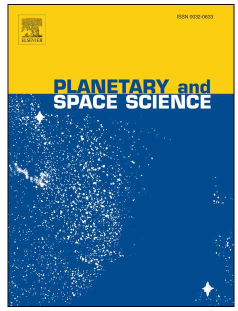

Compaction and sedimentary basin analysis on Mars

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Compaction and sedimentary basin analysis on Mars

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Abstract

Many of the sedimentary basins of Mars show patterns of faults and off-horizontal layers that, if correctly understood, could serve as a key to basin history. Sediment compaction is a possible cause of these patterns. We quantified the possible role of differential sediment compaction for two Martian sedimentary basins: the sediment fill of Gunjur crater (which shows concentric graben), and the sediment fill of Gale crater (which shows outward-dipping layers). We assume that basement topography for these craters is similar to the present-day topography of complex craters that lack sediment infill. For Gunjur, we find that differential compaction produces maximum strains consistent with the locations of observed graben. For Gale, we were able to approximately reproduce the observed layer orientations measured from orbiter image-based digital terrain models, but only with a >3 km-thick donut-shaped past overburden. It is not immediately obvious what geologic processes could produce this shape.

Keywords: Mars, surface; Gale crater; sedimentary basins; sediment compaction

1. Introduction

Under pressure, sediment grains rearrange, fragment, and dissolve at grain contacts. When the pressure is due to geologic overburden, the resulting reduction of porosity is referred to as compaction. Compaction converts sediment to rock, drives basin-scale tectonics, expels pore fluids, and deflects layers. Recognizing compaction from Mars orbit may allow ancient sediment-filled basins to be distinguished from ancient lava-filled basins since compaction is more likely to be observed in highly porous sedimentary rocks than in incompressible volcanic rocks. Once a sedimentary basin has been recognized, accounting for compaction is fundamental to reconstructing the sedimentary history (Allen and Allen, 2005). Compaction-driven flow can drive diagenesis, compaction anomalies may indicate the presence of past overburden (i.e., erosional unconformities), and compaction-driven subsidence can cause faults (Castle and Yerkes, 1976). Finally, differential compaction can

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