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Exploring the Interior and Climate History of Mars with MRO's Shallow Radar Sounder

In five decades since the Mariner 4 mission, an armada of spacecraft with progressively more sophisticated instrumentation has transformed our view of Mars, revealing a planet of outsized features with a complex geologic history and extraordinary climatological variations. Despite the wealth of observations, knowledge of the interior has been largely limited to inferences from surface data until recently. Arriving in the last decade, orbital sounding radars have provided our first looks into the deeper interior from orbit, mapping internal structures within the polar layered deposits, establishing the ice-rich nature of mid-latitude glaciers, and constraining the subsurface properties and stratigraphy of several volcanic and sedimentary terrains. Data from these investigations are typically presented as radargrams, cross-sectional views of returned-signal power. Where coverage is dense, collections of radargrams have been used to map the subsurface in three dimensions. It is a painstaking process, and subsurface features in individual radargrams are often obfuscated by off-nadir surface returns from nearby topography such as crater rims and polar troughs. Taking a new approach, we have developed the means to co-register SHARAD data from all observations of a given area and apply a 3-D imaging process (known as *migration* in seismic parlance) that corrects off-nadir returns and greatly enhances the interpretability of the data. I will discuss our results from the conventional and 3-D methods, focusing on polar discoveries and the new insights they provide into the climatological history of Mars.