IMPACTS ON MARS: EXCAVATION AND/OR HYDROTHERMAL ALTERATION.

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Introduction: Impacts on Mars play an important role in exposing ancient phyllosilicates from buried Noachian rocks. However, they may also provide an opportunity for heating the surface, melting ice and altering rocks [1]. Characterizing the mineralogy at impact sites can constrain the temperatures and likely processes involved. Hydrothermal alteration can form clays such as prehnite when the temperatures reach 200-350 °C [2], or smectites and carbonates typically in the range ~20-150 °C [3]. We are investigating excavation versus impact-induced hydrothermal alteration at several sites on Mars, including at craters in the northern plains [4,5] and craters near Isidis basin [2,3,6,7]. The presence of high-temperature clays at the central uplift or clays in paleolakes could indicate impact-driven hydrothermal alteration, whereas the presence of olivine mixed with phyllosilicates found elsewhere points toward early phyllosilicate formation with little mineralogical alteration due to impact.

Northern Lowlands: Recent surveys of impact craters across the northern lowlands of Mars have documented abundant accurrences of phyllosilicates associated with these features [4,8]. Investigation of rocks containing phyllosilicates and other altered minerals observed at these impact craters [4,5] provides clues about whether impact-driven hydrothermal alteration could have taken place and where ancient rocks have simply been excavated. Most observations of craters in the northern lowlands support impact excavation of ancient phyllosilicate-bearing rocks.

Isidis Basin Region: The entire region around Isidis basin was likely affected by impact melt, and hydrothermal alteration may have occurred in isolated outcrops [9]. Phyllosilicates have been excavated throughout the Syrtis-Isidis region by smaller impacts, but variations in the observed alteration materials are likely due in part to the effects of the Isidis impact as well as subsequent smaller impacts [1]. Hesperian-aged craters such as Toro crater west of Isidis bear evidence of chlorite-prehnite-opal assemblages that are consistent with impact-induced hydrothermal activity [2], but could also have formed via other high temperature alteration processes [10]. Hashir crater in Libya Montes, south of Isidis basin, excavated ancient altered material containing phyllosilicates and carbonates that may have partially formed through low-temperature hydrothermal alteration resulting from the Isidis impact [3]. Investigation of Bradbury crater also in the Libya Montes region indicates multiple alteration minerals that may be consistent with ancient phyllosilicate formation as well as post-Isidis low-temperature hydrothermal alteration [6,7].

Summary: Although impacts on Mars appear to have primarily excavated ancient phyllosilicate outcrops, some impacts may have melted ice in the regolith or released water in hydrated minerals in order to provide localized, moderate aqueous alteration of existing phyllosilicates or volcanic ash. Continuing investigation of the Libya Montes region south of Isidis basin seaks to clarify the affects of the Isidis impact on local alteration.

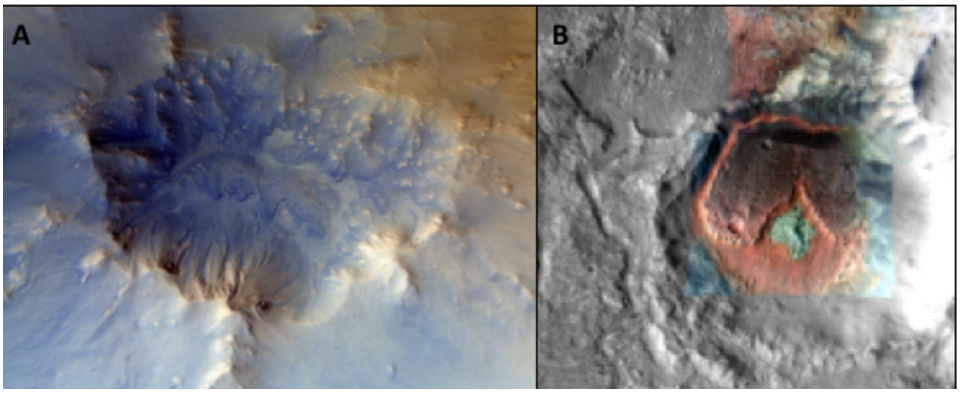

Figure 1. Views of craters in this study where smectite clays have been observed. A) central mound (~8 km dia) of Bamberg crater in the northern plains [5], and B) Hashir crater (~12 km dia) south of Isidis basin [3].

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