Impact-induced alterations of planetary organic simulants: applications to space missions for small bodies

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We systematically investigates shock-induced alteration of planetary organic simulants, which are laboratory analogues of complex organic matter found on primitive planetary bodies, as a function of peak shock pressure and temperature by impact experiments. Our results show that the composition and structure of planetary organic simulants are unchanged upon impacts at peak pressures less than ~5 GPa and temperatures less than ~350ºC. On the other hand, these are dramatically changed upon impacts at pressures higher than 7–8 GPa and temperatures higher than ~400ºC, through loss of hydrogen-related bonds and concurrent carbonization, regardless of the initial compositions of organic simulants. Compared with previous results on static heating of organic matter, we suggest that shock-induced alteration cannot be distinguished from static heating only by Raman and infrared spectroscopy. Our experimental results would provide a proxy indicator for assessing degree of shock-induced alteration of organic matter contained in carbonaceous chondrites. We suggest that a remote-sensing signature of the 3.3–3.6 μm absorption due to hydrogen-related bonds on the surface of small bodies would be a promising indicator for the presence of less-thermally-altered (i.e., temperatures less than 350˚C) organic matter there, which will be a target for landing to collect primordial samples in sample-return spacecraft missions to asteroids or icy bodies.

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