



Using virtual reality to investigate geological outcrops on planetary surfaces

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The year 2016 marked a technological breakthrough, with the first public release of technologically mature virtual reality (VR) headsets. This new affordable technology opens a wide range of applications in geosciences, by providing to the user the possibility to navigate in a 3D environment reconstructed from available imagery. The immersion in the 3D world offered by virtual reality techniques facilitates the scientific interpretation of the data by getting rid of the deformations induced on a classical computer screen, by giving a better comprehension of the scales and of the general context. It also allows the integration of huge data sets, with the possibility to interact and freely navigate in real time in the reconstructed virtual world. We will show test cases that we have computed on the Martian surface on geological features of interest. We use orbital imagery, which provides details as small as 25 cm/pixels with the HiRISE camera onboard the Mars Reconnaissance Orbiter spacecraft, together with in situ data when available (at Curiosity and MER rovers landing sites). The combined use of both orbital and in situ data on the Curiosity rover traverse, including sub-mm resolution images (up to 12.5 μm with the MAHLI instrument), may allow for detailed 3D geological investigations at the outcrop scale. It provides for example the opportunity to investigate Ca-sulfate diagenetic vein complexes observed within sedimentary rocks in Gale crater, which contributes to improve our understanding of the geological processes involved in the formation of these features. Immersion is achieved using either a CAVE system, based on four 3D videoprojectors displaying images on three 2x3m walls and on the ground, or on individual VR headsets (HTC Vive and Oculus Rift). With network access, several users can interact simultaneously in the same virtual world, even when working from different places around the world. This provides new and unprecedented opportunities for scientific investigations, collaborations, education and outreach.