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USING MAGNETOMETRY FOR THE EXPLORATION AND MAPPING OF LAVA TUBES ON MAUNA LOA FOR LUNAR AND MARTIAN ANALOGUES

Abstract

During a two-week lunar simulation mission at the HI-SEAS facility on Hawaii, an airborne magnetometer was used to study the accuracy and reliability of magnetometry for discovering subsurface cavities in tholeiitic basalts. Recently, lunar and Martian orbiters were able to predict the presence of lava tubes on and beneath the surface of these planetary bodies. Looking towards a future with human settlements on these surfaces, lava tubes provide ample opportunity for protection against scourging radiation and micrometeorites, while providing thermal and structural stability, as well as a unique research environment. Therefore, it is of great importance to be able to make high-quality predictions in order to successfully assess which lava fields will be suited for human habitats. Magnetometric studies are mainly used to (re-)discover artefacts in archaeology, coal exploration, or military fields. Approximately 15 years ago, another application was added, when large-scale surveys were conducted on karst-systems, renowned for its presence of sinkholes. After concluding that magnetometry can be used to detect the presence and approximate size of subsurface cavities, especially when combined with Electrical-Resistivity (ER) and Ground-Penetrating-Radar (GPR) field data, many similar surveys have been conducted. The goal of this fieldwork was to test the same methodology on the Ocean Island Basalts of Hawai'i concerning different types of subsurface cavities: Lava tubes instead of karst-caves. By tethering a rope as a 'flight line', a total of 125 measurements were taken. First, measurements over known lava tubes were taken to test the reproducibility of the data, later tests also focused on areas where lava tubes were expected to be present in the near (¡15 m) subsurface. Combining this magnetometric data with data taken from 'traditional' distance measuring during lava tube caving expeditions, the accuracy in estimating the width, height, and depth of the cave, was put to the test. After the analyses, it was shown that although the approximate horizontal size of the lava tube can quite clearly be seen in a negative local anomaly of 1 000 to 7 000 nT. From the profiles and measurements taken, it was proven to be extremely difficult to correctly predict whether a larger anomaly was caused by a shallower lava tube, or a much larger system – or both. For high-stake surveys, such as scouting the potential of a given lunar or Martian lava tube for human settlement, it is therefore recommended to combine magnetometric data with ER and GPR data acquisitions.