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*Shock thermal processing of shergottites using evidence for pressure, temperature, and deformation gradient.*

**Personal Statement**

My interest in science stems from my firm belief that humanity will become a true space-faring civilization in my life-time. I derive great pleasure in knowing that my research contributes to humanity's advance toward becoming a type I civilization.

**Project Description**

Shergottites are a basaltic class of Martian meteorites that are useful in understanding the evolution and internal workings of the Martian planet (McSween Jr. et al., 2015). These meteorites are overprinted by intense shock metamorphism and deformation caused by intense crater-forming impacts on Mars that sometimes eject them to Earth (Fritz et al., 2005). Also, the heavily cratered surface of Mars suggests that these meteorites may have seen multiple impacts before ejection (Barlow, 2008). These overprints obscure the original textures and geochemical signatures in the meteorite. To distill the original Martian signatures, we must first understand the shock deformation and metamorphism in the meteorites. Prominent shock features include melt pockets which are small pockets of molten rock amidst a sea of unmolten rock, amorphization of plagioclase into a glass called maskelynite, nucleation of unique minerals that form only under high pressure within melt pockets, and plastic deformation in pyroxene and olivine (Udry et al., 2020). These features form under differing pressures (P) and temperatures (T) but are usually present simultaneously. This creates an apparent P-T gradient between melt pockets (which must have experienced high enough temperatures to initiate melting) and the rest of the rock.

This pilot study, therefore, aims to explore the nature of the apparent P-T gradient in shergottites. The study will apply a combination of petrographic, chemical, and crystallographic analysis of different mineral phases within shergottites to shed light on their P-T of formation using the petrographic microscope and SEM techniques (SEM/BSE + EDX + EBSD). In particular, the electron backscatter diffraction (EBSD) technique is a novel technique in meteorite studies used to identify crystal phases and quantify deformation in mineral phases. However, this technique hasn't been applied much to studying shergottite shock deformation. These methods will target maskelynite, pyroxene, and olivine phases since they are the most abundant phases in shergottites. These techniques will unravel information about the deformation P-T within the unmolten parts of shergottites. Also, we will explore special systematics in pyroxene that can be used to estimate shock P-T similar to systematics in olivine (Ruzicka & Hugo, 2018). These systematics are mostly temperature dependent and are different from plastic deformation. We will also apply the same methods to shock melt pockets, looking out for high-pressure phases in order to quantify the P-T expressed by molten regions. Furthermore, due to the possibility of multiple impacts in shergottites, we will use EBDS to identify signs of multiple impact events that can skew temperature and pressure estimates. By the end of this research, we expect to 1) quantify the apparent P-T gradient expressed within shergottites 2) identify consistent deformation systematics in olivine and pyroxene that can be used to estimate shock P-T in shergottites and 3) identify the presence or absence of multiple shocks within shergottites.

**Personal Image**