ASTROBIOLOGY WITH A GROUNDBREAKER SAMPLE RETURN MISSION C.P. McKay, Space Science Division, NASA Ames Research Center Moffett Field, CA 94035, cmckay@mail.arc.nasa.gov

Introduction: A Mars Sample Return program will be most likely to succeed if it begins with a small mission focused on technology demonstration and then builds to more capable missions over time. Eventually Sample Return Missions must connect in a direct technological and programmatic way with human missions. For the same reason that the first Mars Rover Mission was a small engineering demonstration, the first Mars Sample Return will be an engineering demonstration. It is important however to consider how we can maximize the science return from such an initial mission. The "Groundbreaker" Sample Return Mission is a design for a first sample return mission with limited capability. Essentially the mission returns soil from near the landing site. The notional landing site for Groundbreaker is Meridiani Planum. Here I show that such a mission can provide important advances for Astrobiology.

Astrobiology goals for soil sample: A first soil sample contributes to Astrobiology goals on Mars in the following ways.

1. Light element geochemistry: Of the biogenic elements (C,H, N, O, P, S) and their compounds we have direct measurements only of elemental S in the soil. The important compounds such as nitrates, carbonates, and phosphates are not determined.

2. Weathering history: The martian soil is a product of chemical weathering. It is not just mechanically ground rock. Various hypotheses have been suggested: acid fog (of Cl and S), occasional liquid water even as films, UV and oxidants, extensive liquid water but long ago. The resolution of this question has important implications for the search for organics and understanding the environmental and geological history of Mars.

3. Residual organics: Direct measurements of organics with high sensitivity remains of interest. The Viking GCMS did not detect organics in the soil with an instrumental sensitivity of a few ppb. The appropriate upper limit in the soil may have been much higher. A few ppb of organics, if present purely as microorganisms places a lower limit of cell count only at about 1,000,000 per gram soil. In addition, it is possible that Mars may have refractory organics that would not have been detected at the temperature reached by the Viking ovens (500ºC). These refractory organics may be the results of oxidative reactions. Thus laboratory measurements oforganics on a returned sample could be of considerable interest even of the sample was heat sterilized.

4. Iron redox state: Iron may he the key redox element in the martian soil and understanding its mineralogical state will help understand the weathering and oxidative history of the soil.

5. Magnetic fraction: The most interesting aspect of the ALH84001 remains the indication of magnetite of the same shape as biogenic magnetite. The soil of Mars has a large, unexplained, magnetic fractions. Is it of biogenic origin? Studies of the shape and size of the magnetic particles and searches for chains of identical particles could be conducted in laboratories on Earth.

6. Interplanetary dust particles: The surface of Mars has presumably been collecting IDPs, and unlike the moon these are not mixed by micrometeoroid impact.

7. Oxidant: The nature of the oxidant(s) may require in situ investigations but analysis of a returned sample may help rule out some proposed hypotheses (such as high peroxynitrate levels).

8. Toxicity of the soil: A soil sample will allow for easy direct determination of any exotic or toxic soil components. This would be directly relevant to future human exploration