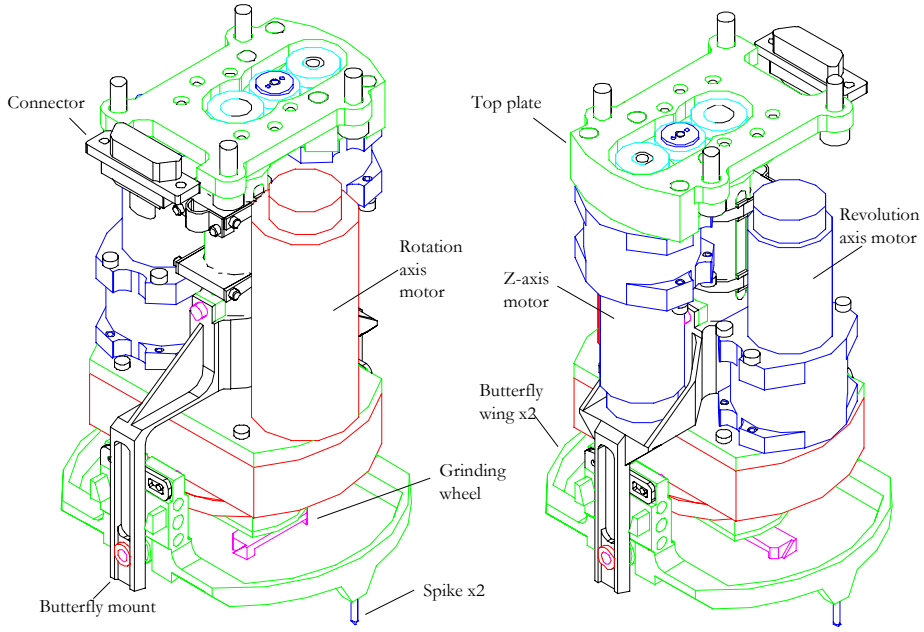
Rock Abrasion Tool (RAT)

The Rock Abrasion Tool (RAT) will be used to penetrate through dust and surface alteration that might be present on rocks, exposing materials more likely to preserve evidence of environmental conditions at the time of their formation. The fresh surfaces exposed can then be characterized by all of the Athena instruments. The RAT is a diamond-tipped grinding tool capable of removing a cylindrical area 4.5 cm in diameter and at least 0.5 cm deep from the outer surface of a rock. This operation takes about 2 hours for a dense basalt.

The RAT has a total of three actuators (see figure). One causes each of two grinding wheels to rotate at high speeds. Each of these grinding wheels has two teeth, which cut out a circular area associated with each grinding head as the head rotates. A second actuator causes the two grinding wheels to revolve around one another at a much slower rate, sweeping the two circular cutting areas around the full 4.5-cm diameter cutting region. Finally, a third "z-axis" actuator translates the entire cutting head toward the rock, causing it to penetrate to the commanded depth.



Mechanical Design of the RAT

In order to grind a rock, the IDD places the RAT directly against it. Contact is made on two small spikes external to the grinding heads, and a ring surrounding the heads can adjust in two orthogonal axes to the orientation of the rock surface. Once pressed firmly against the rock by the IDD, all further actuations take place within the RAT itself. Rotation and revolution of the grinding wheels is initiated, and they are slowly translated toward the rock surface by the z-axis actuator until contact is made. Encoders monitor penetration progress, and allow closed-loop

control of the grinding process. A dust skirt around the cutting surfaces helps to prevent release of dust that might contaminate instruments.

The RAT is designed to preserve petrologic textures of the prepared rock surfaces as fully as possible, so that they can be viewed effectively using the MI. The grinding process is slow enough that no measurable modification of rock chemistry or mineralogy by frictional heating is anticipated. The grinding wheels are designed so that contamination of the exposed surface by cuttings from the rock (and previous rocks) is minimized. Grinding wheel materials are selected so that there should be no detectable contamination of rock surfaces due to wear of the grinding heads themselves.

During the operation of the RAT, the rover will monitor currents, temperatures, and encoder readouts for all three RAT actuators. These data can be used to infer information about the strength properties of the rocks that have undergone grinding. A pre-flight test program is planned to establish some of the relationships among these parameters and rock strength, but this program will be limited in scope. Further post-launch testing with an engineering model or flight spare RAT is possible.