ODIN - A PROTOTYPE MARS IN-SITU LUMINESCENCE READER FOR GEOCHRONOLOGY AND RADIATION MEASUREMENTS

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Abstract

We present ODIN, a prototype robotic luminescence reader for dating of regolith on the surface of Mars. ODIN is based on Optically Stimulated Luminescence, a method to determine the radiation dose absorbed by insulating crystalline materials. The technique is frequently used to determine the depositional age of mineral deposits on earth and has also been suggested for in situ dating of minerals on the surface of Mars.

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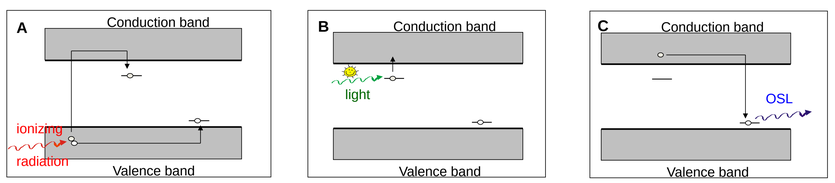
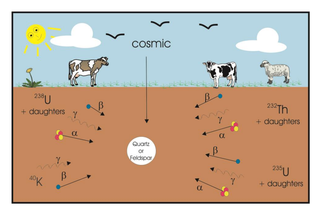
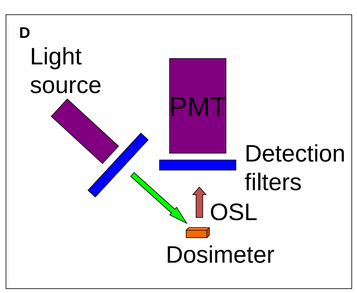
What is Optically Stimulated Luminescence (OSL) Dating?



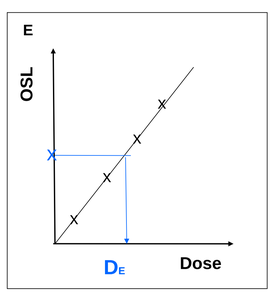


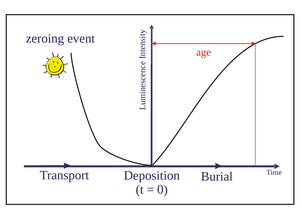
OSL dating uses minerals like quartz and feldspars as dosimeters. The minerals absorb radiation from radioactive nuclides and cosmic radiation. During burial a trapped charge population builds up, which is “bleached” when the mineral is exposed to sunlight. The dose absorbed during burial can be determined with OSL. To calculate the age the rate of irradiation must be known:

Age = Dose / Dose Rate



Exposure to ionizing radiation will lead to build-up of a trapped charge population within a dosimetric material (A). When stimulated with light the charges will recombine and the material will emit “optically stimulated luminescence” (B-D). The intensity of the OSL signal is a function of absorbed radiation dose (E).

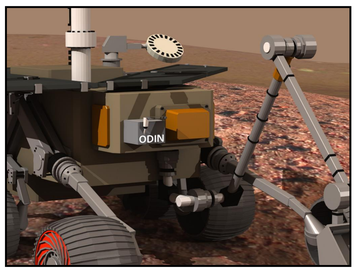


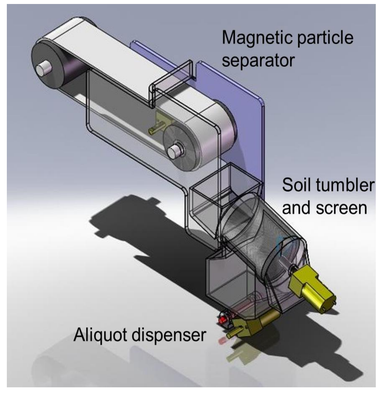


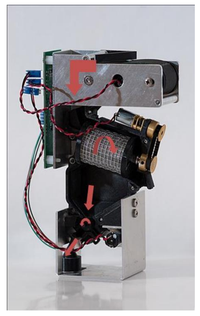
ODIN Prototype

in collaboration with ICx Technologies

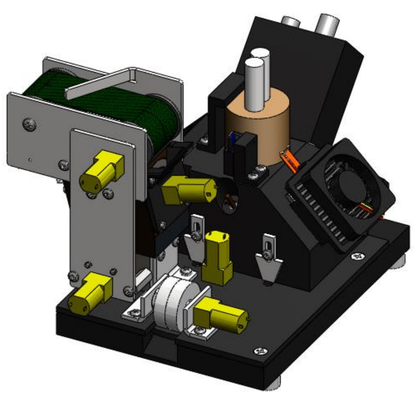
Our Optical Dating Instrument, ODIN, is intended for a lander or rover mission to Mars. It is equipped with all necessary components for OSL dating such as light sources for sample stimulation, a photo detector for sensing the luminescence signal, a heater to control the stimulation temperature, and a radiation source for sample calibration. It is also equipped with a soil tumbler assembly to separate magnetic particles and to screen grains smaller than 250micron.

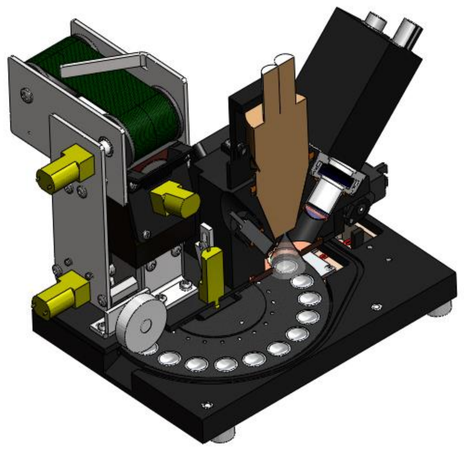






Schematic drawing of the sample preparation unit and photo indicating the movement of the soil through the system.
Regolith is placed onto the green receiving belt. Large aggregates are removed by the angled aluminum bar positioned above the belt. Magnets located in the roller behind the aluminum bar retain magnetic particles—which would skew OSL readings—while the non-magnetic particles fall into the sifter/tumbler. The tumbler runs the soil through sized screens to break up aggregates and deliver only appropriately sized particles to the aliquoting assembly. A sample aliquot is dispensed into an individual copper sample cup in the sample transport platen by running the aliquoting assembly . The platen is then rotated to the next position to prepare for receipt of another sample aliquot. By reversing the drive motors each section of the soil handling system can rid itself of unwanted regolith.





Schematic drawing of the integrated system and photo. Some components have been removed to allow viewing the inside of the system. Clearly visible are the conveyor belt of the sample transport system, the brush to remove measured aliquots, the turntable with the sample cups, the X-ray source (brown, cut in half), the PMT (right side, facing the sample at an angle) and the heater below the turntable. The connectors for motors are indicated in yellow.
Once a soil aliquot has been placed in one of the twenty cups on the sample transport platen, it may be rotated into a shielded location, the interrogation region, or then disposal region. The interrogation region provides line-of-sight between the sample cup and an X-ray source, a blue illumination source, a red illumination source, and a photomultiplier tube. The weight without X-ray source is 1.7 kg, the X-ray source with HV supply adds 0.5 kg).