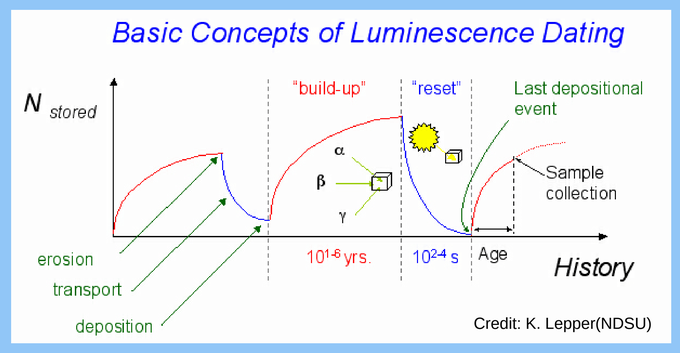
Optically Stimulated Luminescence Dating

(Instrument design for Mars Applications)

[1]Marvin Suggs, [2]Derek Sears, [2]Alan Mantooth
[1]Arkansas Tech University, Russellville, AR. Email: msuggs@atu.edu
[2]Arkansas Center for Space and Planetary Sciences

Abstract: To examine the geological and climatic history of Mars, we investigate the design of an instrument for robotic in-situ optically stimulated luminescence dating.

Introduction



"Build-up"

- Ionizing radiation builds up energy in subsurface sediments over time

"Reset"

- Sunlight or intense heat releases the stored energy in the form of light, resetting the solar age

"Age"

- We can use this phenomenon to detect the time of the last depositional event i.e. burial age

Scientific Benefits

- Determination of absolute ages for younger Martian terrains
- Establish a chronology of geological events that have shaped the Mars surface
- Further investigations of the history of water on Mars
- Resolve uncertainties of Mars' past climatic history

Instrument Design

Design Requirements for Space Applications

- Low volume (Requires smaller amounts of shielding)
- Low weight (Decreased cost)
- Low power (Reduced power strain on the limited energy supply)
- Valuable data acquisition for the advancement of our knowledge

Instrument Objective

- To accurately calculate the equivalent dose and dose rate of radiation in Mars sediments

Electronic Design Features

- Optical Stimulation system- Ultra-bright LED arrays **(OSL/TL)**
- Light detection system- Photomultiplier tubes **(OSL/TL)**
- Irradiation source- mini x-ray tube **(X-ray)**
- Sample Transportation – Turntable with **(motor control)**

Ultra Bright LED arrays
- *Green/IR stimulation*

Photomultiplier tube
- *Detects from UV to red*

Mini X-ray tube
- *Low power/high dose rate*

Turntable
- *forward/reverse directions*

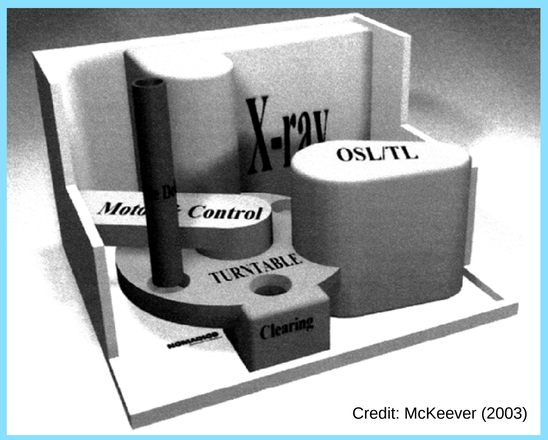


Fig. 1: *A conceptual design of an OSL dating instrument*

Work In Progress

Research of luminescence dating and its adaptation for utilization on Mars
- Determining precise ways to autonomously calculate the equivalent dose and dose rates on a land based Mars rover

Research of vital electronics for a conceptual instrument design
- Examine operational methods of essential electrical systems needed for implementation

Challenges

- The mineralogy of the Martian surface
- The effect of the Mars temperature range and radiation on the luminescence process
- Anomalous fading of the luminescence signal

Future Work

- Design of electronics to withstand radiation and the wide temperature range of the Mars environment
- Simulations to demonstrate performance in Mars environment
- Characterization of OSL measurements of poly-mineral samples found on Mars
- Resolution of effects the temperature range and radiation has on the luminescence process

Reference: *[1] S.W.S. McKeever and D. Banerjee (2003) Radiation Measurements.,37, 527-534.*

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