Measuring Rock Hardness in the Field

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Investigation of Rock Weathering

The major factors that influence rock weathering and the susceptibility to erosion include:
(1) the intensity and duration of thermal stress a rock face is subjected to
(2) the presence or absence of water
(3) the development of microbial activity on or under the surface
(4) the cycling of chemicals and salts which cause disintegration of the mineral matrix

Rock hardness can be used to estimate the progression of weathering processes and areas of weakness. However, note any irregularities observed on the rock surface that could influence hardness readings, e.g. moisture, hardening, flaking, microbial activity, and combine rock surface hardness measurements with other measurements such as saturation.

Considerations at the Outcrop Scale

- Account for external factors such as temperature fluctuations and precipitation levels, as well as microclimate variations due to overhangs etc.
- Closely examine internal structural controls in heterogeneous outcrops. Rock faces produced by fluctuations in sea level over millions of years are likely to exhibit variable rates of weathering. Similarly localized folding or faulting will affect the factors listed above.
- Rock surface hardness should be taken as a relative measurement of weathering and placed within the geological, environmental and spatial context of the site.

Methods for Measuring Rock Weathering

1. Mohs scale. The relative hardness test for minerals (see section XX) can also be applied to homogenous material to determine which sections are most weathered, or which sections might be more susceptible to weathering in the future.

Rebound devices

These use a spring-loaded mechanism to measure rebound of a metal object against a rock face. Devices are typically lightweight, simple and robust. Calibration using a block from the supplier is essential before embarking on fieldwork.

2. The Schmidt Hammer is widely used in geomorphological research for dating rock surface exposure time and estimating the effect of environmental controls such as aspect on rock weathering (Hansen et al., 2013). A dial indicates the rebound value (R-value) on a scale from 0 to 100 in ascending hardness.

- The device must be placed perpendicular to the rock surface to avoid erroneous readings
- This device is particularly good for harder rock surfaces such as granite.
- The N-type works with high impact energy and will indent soft rocks.

- The L-type is suitable for brittle objects or structures less than 100 mm thick.
- An optional mushroom plunger spreads the impact over a larger area if the surface is too fragile for point-impact.

3. The Equotip is the 'little brother' of the Schmidt Hammer. It uses a small rebound 'bullet' made of carbon tungsten which is fired by first compressing and then releasing the coil in the device. Recompression of the coil by the rebounding bullet generates a value for of both impact and rebound velocity used to calculate Leeb value: L = Vr/Vi x 1000. Vr is the rebound velocity and Vi is the impact velocity (Aoki and Matsukura, 2008). Higher values indicate harder rock surface hardness.

- Programmable for the appropriate rebound test (i.e. concrete or steel) and impact angle, or used on a fully automatic setting.
- Stores hundreds of measurements unlike older Schmidt Hammer models.
- Measurement scales are different from Schmidt Hammer (R-value vs Leeb value)
- The piston can collect dust when used repeatedly on heavily weathered surfaces and requires regular cleaning and replacement.
- Because of the lower impact velocity, the Equotip is more sensitive to small scale irregularities such as edges and cracks

4. Piccolo is the smallest of the impact devices (pocket-sized member of the Equotip family) and measures hardness on the Leeb scale allowing for direct comparison of measurements.

- It is even more sensitive to localized variability and may create noise in the dataset.
- Because of its sensitivity it is well suited for small scale investigations into hardness loss such as small building blocks or small samples in environmental simulations.
- Highly portable and useful in remote locations and difficult terrain

Note: Smaller devices can be more sensitive to surface irregularities, leading to potentially a large variability in the data set. When selecting a particular rebound device one has to keep in mind the size of the rock structure (i.e. outcrop vs small laboratory sample) and the surface structure as changes in surface smoothness can lead to variability in the data. Users can affect readings; small changes such as the pressure exerted on the piston during the rebound measurements and angle of impact can cause fluctuations in the readings, especially if multiple researchers work on the same data set. These small inconsistencies can be traced through statistical analysis of the data set and repeat measurements by multiple users on the same site (see Viles *et al.*, 2011).

References

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