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Boulders, biology and buildings: Why weathering is vital to geomorphology (Ralph Alger Bagnold Medal Lecture)

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Weathering is vital to geomorphology in three main senses. First, it is vital in the sense of being a fundamental and near-ubiquitous earth surface process without which landscapes would not develop, and which also provides a key link between geomorphology and the broader Earth system. Second, weathering is vital in the sense that, as it is heavily influenced by biotic processes, it demonstrates the importance of life to geomorphology and vice versa. In particular, weathering illustrates the many cross-linkages between microbial ecosystems and geomorphology. Finally, it is vital in the sense that weathering provides an important practical application of geomorphological knowledge. Geomorphologists in recent years have contributed much in terms of improving understanding the deterioration of rocks, stone and other materials in heritage sites and the built environment. This knowledge has also had direct implications for heritage conservation. This lecture reviews recent research on each of these three themes and on their linkages, and sets an integrated research agenda for the future.

Weathering as a key process underpinning geomorphology and Earth system science has been the subject of much recent conceptual and empirical research. In particular, conceptual research advances have involved improving conceptualisation of scale issues and process synergies, and understanding weathering in terms of non-linear dynamical systems. Empirical advances have included the development of larger datasets on weathering rates, and the application of a wide range of non-destructive and remote sensing techniques to quantify weathering morphologies on boulder and rock surfaces. In recent years, understanding of the complex linkages between ecology and geomorphology (sometimes called biogeomorphology) has advanced particularly strongly in terms of weathering. For example, the influences of disturbance on biota and weathering have been conceptualised and investigated empirically in a range of settings including rocky coasts. The concept of bioprotection has also been explored within the context of weathering in deserts and other environments. Practical applications of geomorphological knowledge on weathering (including biogeomorphic aspects) have burgeoned in recent years. In conceptual terms, non-linear dynamical systems ideas have been applied to stone deterioration and the concept of durability, and biogeomorphic disturbance ideas expanded to investigate the impact of climate change on biota growing on stone heritage. The concept of bioprotection has been applied fruitfully to heritage conservation practice. Empirical investigations, for example of cavernous weathering on limestone buildings and green algal growths on sandstone structures, illustrate the application of new methods.

Future research should enhance the vitality of weathering studies, through making better use of innovative technologies and improving cross-disciplinary research.