When did making mountains the modern way begin?[1]

What with 'tectonic shifts' and 'tectonic proportions', the processes and terminology of Earth's major structural change or tectonism have invaded everyday language. Now geological research is adding a new dimension – 'changing tectonic regimes', the US presidency comes to mind. So what is a 'change in tectonic regime'?

The process of mountain building and major structural change on Earth underwent a significant change in style in the deep geological past. Early Earth was hotter and as a result the planet's outer lithospheric rock layer was thinner and weaker, consequently there was no plate tectonism or subduction as we know it today. When the change to the present plate tectonic regime happened has been a matter of debate. Now researchers in Cambridge and Canada have discovered that the fundamental shift to modern style mountain building occurred at least 1,830 million years ago in what are known as Palaeoproterozoic times.

Owen Weller from the Department of Earth Sciences in the University of Cambridge and Marc St-Onge of the Canadian Geological Survey compared the rocks of the geologically recent Himalayan mountain belt (orogen), with those of the ancient Trans-Hudson mountain belt in Canada (Nature Geoscience DOI:10.10.1038/NGEO2904). Both orogens have similar dimensions and timescales but the older Palaeoproterozoic age Trans-Hudson orogen (around 1,800 million years old) was thought to lack rocks formed by high-pressure, low-temperature metamorphism. This absence implied that the mantle, which underlies the lithosphere, was hotter in Palaeoproterozoic times. However fieldwork by Weller and St-Onge has uncovered previously unsuspected similarities between the two mountain belts.

One of the characteristic high pressure and low temperature metamorphic rock products of modern mountain belts like the Himalayas, which began forming some 50 million years ago, is eclogite, often a visually striking and beautiful rock containing large red garnet crystals surrounded by green omphacite. The name 'eclogite' means 'chosen rock' and was coined nearly 200 years ago by the eminent French mineralogist Rene Hauy (1743-1822) in the year in which he died. These distinctive rocks were thought to be absent from the Trans-Hudson orogen. Despite its great age, this deeply eroded ancient mountain belt is superbly well exposed across North America, thanks to the powerful and deep-cutting erosion of the Quaternary Ice Ages. And, it was in a well-exposed outcrop of metamorphic rock to the east of Hudson Bay in northern Quebec that Weller and St-Onge found the first eclogites to be identified in the Trans-Hudson orogen.

Their analysis of the eclogite minerals shows that the pressure-temperature conditions and relative timing of the metamorphic process,

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which produce eclogites is comparable in both orogens. From this similarity, Weller and St-Onge conclude that modern style plate tectonic processes, which include deep subduction of continental crustal rocks occurred at least 1,830 million years ago.

Earth's tectonic regime will change again when the planet's core has cooled to such an extent that there will not be enough energy to drive plate processes and there is not enough liquid water to sustain subduction but luckily that change is about as remote in the future as the last change was in the past.

Douglas Palmer

Owen Weller and Marc St-Onge looking at the depths of Palaeoproterozoic time in the eroded rocks of Canada's Trans-Hudson mountain belt