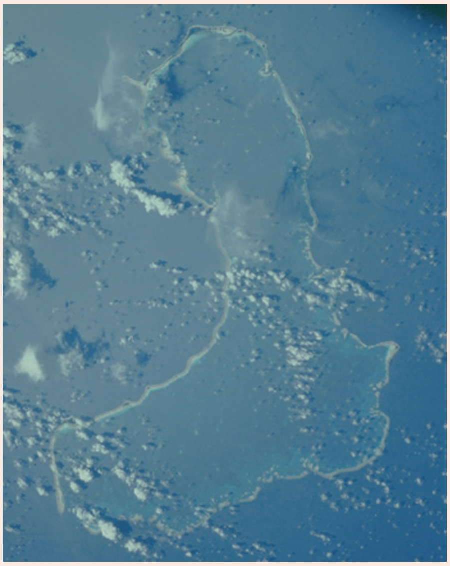
PLATE TECTONICS

Igneous triangle

Vast accumulations of igneous rock, termed large igneous provinces, are found in various regions of the globe. These masses of rock were erupted very rapidly — geologically speaking — usually over a few million years or less, and they typically cover thousands of square kilometres. In the geological record, the emplacement of large igneous provinces often coincides with changes in climate. This volcanic activity has also been associated with mass extinction events: it is likely that such massive rates of lava extrusion caused significant changes to both the atmosphere and seawater, as greenhouse gases such as carbon dioxide were released with the lava flow.

With an area similar to that of Western Europe, the Ontong Java Plateau (pictured) is one of the biggest of these large igneous provinces, and it lies in the western Pacific, north of the Solomon Islands. A few thousand kilometres to the east is the smaller Manihiki Plateau, and a similar distance to the south between these two plateaux is the Hikurangi Plateau, making up the third corner of an immense triangle of igneous rock. Although they are a considerable distance apart today, it is thought that the three large igneous provinces, referred to collectively as Ontong Java Nui, shared a common origin in the Early Cretaceous around 125 million years ago.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Piecing this giant puzzle together is a challenging task, however, with many complex factors to consider. Katharina Hochmuth and colleagues (*Geochem. Geophys. Geosyst.* http://doi.org/85x; 2015) now suggest that the Ontong Java Nui 'super-large' igneous province is the result of an upwelling plume interacting with a spreading ridge that existed at the time of eruption, between the Pacific and Phoenix tectonic plates.

Similar to rifting processes in Iceland today where two plates are moving apart, different rates of spreading may have led to a variety of thicknesses of crust being created at different times. This may account for the differences in crustal thickness between the three plateaux. The researchers note that the largest volumes of lava, which resulted in the formation of the expansive province, would have occurred when the plume was directly below the active spreading centre. The team go on to simulate the subsequent break-up of the super-large province using the global plate tectonic GPlates model, and show how the three plateaux began to move to their current configuration as the crust stretched, sheared, rifted and rotated over the subsequent tens of millions of years.

This remote area in the western Pacific is difficult to study, but gradually researchers are piecing together the evidence from a range of geochemical and geophysical data, and building a clearer picture of what may have occurred there in the Early Cretaceous to produce this unusual super province.

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PALAEOCLIMATE

The dynamics of cold events

The last glacial period and deglaciation were marked by abrupt, millennial-scale climate changes. Changes in the North Atlantic meridional overturning circulation were important contributors to rapid climate variability, but did not act alone.

Katrin J. Meissner

Northern Hemispheric warming during the last deglaciation was interrupted by several substantial abrupt cold events. The Younger Dryas, which lasted from 12,900 to 11,500 years ago, was the largest of these events. The cooling pattern of the Younger Dryas resembles earlier, glacial cold phases called stadials. These phases were characterized by widespread Northern Hemispheric cooling mainly centred on the North Atlantic region[1,2]. Changes in the Atlantic meridional overturning circulation (AMOC) and associated heat transport are most commonly invoked as the main cause for the observed cooling[3], but other mechanisms have been suggested[4], particularly for the Younger Dryas[5–7]. Writing in *Nature Geoscience*, Gottschalk *et al.*[8] show evidence for the pivotal role played by the Atlantic Ocean during the transitions between cold stadials and warm interstadials over the past 62,000 years. Also writing in *Nature Geoscience*, Renssen *et al.*[9] identify roles for changes in ocean circulation, radiative forcing from dust or solar irradiance, and atmospheric circulation during the Younger Dryas cold event.

Major ice calving events and their associated freshwater flux into the North Atlantic are thought to have been the

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