Depending on the subsequent rate and direction of plate motion, the microplates could remain within the convergent margin system or be transferred to another tectonic plate. For example, the New Zealand microplate now straddles the Pacific–Australian plate boundary; in the future, if these plates separate, portions of the microplate may also diverge, and follow different travel paths on their respective tectonic plates. This demonstrates the manner in which microplates and their associated continental crust move throughout the globe.

Indeed, the genesis of wandering microplates, known as 'exotic' terranes, has baffled geologists for decades[6]. The Tethys Ocean system produced microplates involved in the Alpine collisional zone[7], the Cache Creek terrane[8] and Klamath Mountains province[9] in North America, whereas the Rheic Ocean yielded the continental microplates that now constitute the main part of Central America[10]. Our understanding of both systems could greatly benefit from studies based on Rey and Müller's methods. However, complex systems such the Gondwana margin, where material most likely flowed in and out of the plane simulated by current models[3], can only be fully addressed with the continued refinement and development of three-dimensional modelling.

By examining the role of mantle buoyancy, Rey and Müller[2] have made an innovative foray into a complex realm of continental dynamics, and offered provocative yet plausible explanations for the rapid evolution of some orogenic plate margins. The patterns revealed by their simulations may be used to recognize and interpret microplate formation not only at the East Gondwana margin, but in settings across the globe. ❐

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References

1. Collins, W. J. *Tectonics* **21,** 1024 (2002).
2. Rey, P. F. & Müller, R. D. *Nature Geosci.* **3,** 257–261 (2010).
3. Siddoway, C. S. in *Antarctica: A Keystone in a Changing World: Proc. 10th Int. Symp. Antarctic Earth Sciences* (eds Cooper, A. K. *et al.*) 91–114 (National Academies, 2008).
4. Bryan, S. E., Ewart, A., Stephens, C. J., Parianos, J. & Downes, P. J. *J. Volcanol. Geotherm. Res.* **99,** 55–78 (2000).
5. Bialas, R. W., Buck, W. R., Studinger, M. & Fitzgerald, P. G. *Geology* **35,** 687–690 (2007).
6. Coney, P. J., Jones, D. L. & Monger, J. W. H. *Nature* **288,** 329–333 (1980).
7. Schettino, A. & Scotese, C. in *Reconstruction of the Evolution of the Alpine-Himalayan Orogen* (eds Rosenbaum, G. & Lister, G.) *J. Virtual Explorer* **8,** doi:10.3809/jvirtex.2002.00056 (2002).
8. Johnston, S. T. & Borel, G. D. *Earth Planet. Sci. Lett.* **253,** 415–428 (2007).
9. Snoke, A. W. & Barnes, C. G. in *The Development of Tectonic Concepts for the Klamath Mountains Province, California and Oregon* (eds Snoke, A. W. & Barnes, C. G.) 1–29 (GSA Special Paper 410, GSA, 2006).
10. Nance, R. D. & Linneman, U. *GSA Today* **18,** 4–12 (2009).

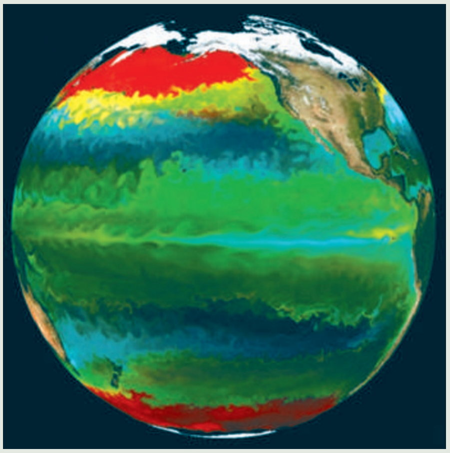
ECOLOGY

Seasons and diversity

Phytoplankton form the foundation of the marine food web. *En masse*, these single-celled organisms take up large quantities of carbon dioxide from the atmosphere and, if not consumed near the surface, deliver it to the bottom of the ocean when they die.

Numerous studies have examined how nutrient levels affect phytoplankton abundance — a primary focus being the impact of iron additions. Less is known, however, about the factors regulating phytoplankton diversity. This is a potentially important omission, as the diversity of these populations could also influence the amount of carbon taken up by the oceans, given that ecosystem diversity is thought to affect function.

Using model simulations, Andrew Barton and colleagues show that phytoplankton diversity should be high in tropical and subtropical waters, as a result of the low seasonal variability at low latitudes (*Science* doi:10.1126/science.1184961; 2010). In their model, biodiversity declines towards the poles as seasonal variability becomes more pronounced. Indeed, observations of many terrestrial and marine organisms, including marine microbes, document such a pattern of declining diversity with increasing latitude.



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Seasonal changes in the environment affect phytoplankton diversity via intermittent nutrient supplies. As a result, simulated diversity floundered in temporally changing environments, and those species able to grow fast during high-nutrient periods survived longer than the slow growers. But in the presence of more stable nutrient loads, a diverse community of microorganisms thrived.

The frequency and strength of the oscillation in environmental conditions determined the time it took for species to die out. Multiple species co-existed quite happily for a thousand model-years or more when relatively weak temporal variations were imposed with a period of either years or days — in other words when they mimicked conditions in the tropical and subtropical oceans. But species died off rapidly under the influence of stronger oscillations with a period of months, typical of polar and subpolar waters.

Hotspots of diversity were superimposed on the latitudinal gradient, and coincided with areas of energetic circulation, such as the Gulf Stream. In these regions, ocean currents can replenish depleted phytoplankton stocks, and the continuous mixing of species from different regions probably prevents a single species from becoming locally extinct.

In the simplified model world, phytoplankton diversity is determined in any one location by the balance between the competitive elimination of species and the addition of nearby phytoplankton stocks by ocean currents. The suggestion is plausible, but only a comprehensive ocean survey across latitudes, spanning calm waters as well as locations of vigorous mixing, can confirm the idea.

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