Investigating the role of oceanic plateaus in early continental growth

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Abstract How, and why, were the first continents formed? This is a fundamental question regarding the evolution of the Earth, yet scientists can still not conclusively answer it. Nevertheless, resolving this question is essential for earth scientists, chemists and biologists as the generation of the continents are ultimately responsible for the chemical evolution of the planet's interior, hydrosphere and atmosphere throughout geological time. The earliest continental crust formed around 4 Ga and dominantly consisted of plagioclase-rich trondjhemite, tonalite and granodiorite/dacite (TTG/D) suites. However, formation of early crust is poorly understood. A rare type of modern island arc lava termed Adakite is the closest present-day compositional analogue to, in particular, mid-late Archaean (~3.5-2.5 Ga) crust but an adequate compositional analogue for the earliest Eoarchaean (4.0-3.6 Ga) crust remains elusive. It is possible that the underthrusting, subduction and/or underplating of oceanic plateau rocks and subsequent metamorphism causes them to undergo partial melting and generate TTG/D and adakite rocks with Eoarchaean-like compositions. This scenario is rare and one of the few examples is found in the northern sector of the Andean Mountain chain in Colombia. From ~80 Ma the Caribbean oceanic plateau and subsequent hotspot trail(s) (e.g. the Malpelo Ridge) have collided and partially subducted/underthusted/ underplated beneath the Colombian sector of the northern Andes. Therefore, lavas of the Colombian Cordillera may be derived from fusion of oceanic plateau-like metabasic protoliths and have adakitic compositions similar to Eoarchaean crust. Consequently, this study will focus on the petrogenesis of Colombian magmatic rocks derived from 14 Colombian volcanic centres from Cerro Bravo in the North to Cerro Negra de Mayasquer in the South. The outcomes of this study will significantly increase our knowledge of continental crust formation on the earliest Earth.

In detail, the project will involve:

1. An extensive field season collecting igneous rock samples in Colombia with the aid of the Ingeominas: Colombian Geological Survey.
2. A petrographic study using thin sections cut at the University of Birmingham to assess the primary and possible secondary mineralogy of the Colombian rocks.
3. Analysing the igneous rocks for a full range of major and trace elements using newly installed ICP-OES and ICP-MS facilities at the University of Birmingham
4. Determining Sr-Pb-Nd-Hf radiogenic isotope systematics on the samples at the NERC Isotope Geosciences Laboratory via a NIGFSC application(s).
5. Combining all the above techniques into determining the petrogenesis of the Colombian lavas and assessing if they are derived from oceanic plateau-like source regions and are, thus, modern analogues for Eoarchaean-like adakites/TTGs.

Training This project will enable the student to learn about geological fieldwork in tropical environments and acquire knowledge of determining the major and trace element geochemistry of igneous rocks using ICP-OES and ICP-MS analytical techniques. Further training will be given in interpretation of the petrogenesis of volcanic and intrusive rocks. The student will be part of a new multidisciplinary research group at UoB and will forge national links with Cardiff University and the NERC Isotope Geosciences Laboratory and international links in South America.

Background reading

Hastie, A.R., Kerr, A.C., Mitchell, S.F., Pearce, J.A., McDonald, I., Millar, I., Wolstencroft, M., 2010. Do Cenozoic analogues support a plate tectonic origin for the Earth's earliest continental crust? Geology 38, 495-498.

Martin, H., Smithies, R.H., Rapp, R., Moyen, J-F., Champion, D., 2005. An overview of adakite, tonalite-trondhjemite-granodiorite (TTG), and sanukitoid: relationships and some implications for crustal evolution. Lithos 79, 1-24.

Smithies, R.H., Champion, D.C., Cassidy, K.F., 2003. Formation of Earth's early Archaean continental crust. Precambrian Research 127, 89-101.

White, R.V., Tarney, J., Kerr, A.C., Saunders, A.D., Kempton, P.D., Pringle, M.S. and Klaver, G.T., 1999. Modification of an oceanic plateau, Aruba, Dutch Caribbean: Implications for the generation of continental crust. Lithos. 46, 43-68.

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