The vanadium isotope evidence for emergence of felsic crust after 3 Ga

Fang Huang1, Shengyu Tian1, Roberta L. Rudnick2, Yuhan Qi1, Fei Wu3, Yue Cai4, Richard M. Gaschnig5

1 School of Earth and Space Sciences, University of Science and Technology of China, Hefei, Anhui 230026, China.
2 Department of Earth Science, University of California–Santa Barbara, CA 93106, USA.
3 Florida State University, Tallahassee, FL 32306, USA.
4 Lamont-Doherty Earth Observatory of Columbia University, 61 Rt. 9W, Palisades, NY, 10964, USA.
5 Department of Environmental, Earth and Atmospheric Sciences, Univ. Massachusetts. Lowell, MA 01854, USA.

The earth is different with other terrestrial planets in having evolved continental crust1, a feature that is fundamental for evolution of the solid earth, the rise of atmospheric oxygen, and chemical cycling from the crust to the oceans to the mantle. Although it is well accepted that the oceanic crust forms by partial melting of the mantle and is subducted at convergent margins, the origin of the continental crust is still controversial. In particular, there has been recent debate regarding how and whether the continental crust composition has changed over time2-4.

We measured V isotope compositions for arc lavas and ancient glacial diamicrites5 to constrain the temporal variation of average SiO2 contents of the continental crust. Vanadium isotope ratios (δ51/50 V) are positively correlated with wt.% SiO2 in arc lavas and they are not obviously modified by alteration during weathering and fluid-rock interaction6,7. Therefore, δ51/50 V of glacial diamicrites can be used as a reliable proxy for silica contents of the upper continental crust. The δ51/50 V of the diamicrites increase from the Archean to the Paleozoic, suggesting that the silica contents of average upper continental crust increased from ~ 49 wt.% at 3.0 Ga to ~64 wt.% at 0.3 Ga. These data define the emergence of felsic continental crust after 3.0 Ga ago, which may have also marked the onset of plate tectonics.