

### A NEW CHEMICAL SEPARATION METHOD FOR MC-ICPMS MEASUREMENT OF TITANIUM ISOTOPIC COMPOSITIONS IN NATURAL MATERIALS

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**Introduction:** Nucleosynthetic studies showed that neutron-poor (e.g., <sup>46</sup>Ti) and neutron-rich (<sup>50</sup>Ti) Ti isotopes have different origins [1]. However, a well-resolved linear relationship between <sup>46</sup>Ti and <sup>50</sup>Ti isotope anomalies was discovered in normal Ca-Al-rich Inclusions (CAIs) and bulk meteorites when normalizing to a fixed <sup>49</sup>Ti/<sup>47</sup>Ti ratio [2]. This result raises several critical questions, including where Ti isotope anomalies come from, what the carrier phases are, and how these carrier phases were distributed and preserved during evolution of the solar system. In order to answer these questions, we have developed a new separation procedure for Ti, Zr and Hf, three elements with similar cosmochemical behavior, but with diverse nucleosynthetic origins. Here we report our approach and preliminary results for Ti.

**New separation procedure:** Titanium was separated via a two-stage procedure using TODGA and AG1-X8 resins, respectively. Samples were loaded onto a 2-mL TODGA cartridge, rinsed with 10 mL 12M HNO<sub>3</sub> to remove major matrix elements [3], and titanium was collected with Mo and minor Nb, Ta and W in 10 mL 12M HNO<sub>3</sub> + 1 wt% H<sub>2</sub>O<sub>2</sub>. The second separation stage is a modified version of a previously used procedure [4], using a 0.8-mL column (AG1-X8). It removed major matrix with 10 mL 4M HF independently from the first column and separated Ti from Mo, Nb, Ta, and W with 9M HCl + 0.01M HF.

**Titanium isotopic analysis:** Titanium isotopic analyses were obtained by a Thermo Neptune MC-ICPMS using sample-standard bracketing technique. Samples were introduced in a 2% HNO<sub>3</sub>-0.005% HF mixture via an Aridus desolvating nebuliser. Our bracketing standard is a Ti solution from Alfa Aesar. The positions of Faraday cups correspond to the species <sup>44</sup>Ca<sup>+</sup>, <sup>46</sup>Ti<sup>+</sup>, <sup>47</sup>Ti<sup>+</sup>, <sup>48</sup>Ti<sup>+</sup>, <sup>49</sup>Ti<sup>+</sup> and <sup>50</sup>Ti<sup>+</sup> (cycle 1) and <sup>48</sup>Ti<sup>+</sup>, <sup>49</sup>Ti<sup>+</sup>, <sup>51</sup>V<sup>+</sup>, and <sup>53</sup>Cr<sup>+</sup> (cycle 2). All measurements were made at high resolution.

**Preliminary results:** Nine samples have been measured: three geostandards (two USGS AGV-2 andesites and one USGS BCR-2 basalt), three carbonaceous chondrites (two Allende and one Murchison), two ordinary chondrites (St.-Severin), and one eucrite (Juvinas). All the results are in good agreement with the data from Trinquier et al. [2], except for those of the two Allende samples which, however, both agree with the mean value of six measurements from Leya et al. [5], within the uncertainties. Our explanation is that it is due to sample heterogeneity. The Allende sample that we measured is the Smithsonian reference powder, which was homogenized from 4 kg of meteorite, but smaller samples of Allende can. More interestingly, all nine samples show significant correlated variations in  $\epsilon^{46}\text{Ti}$  and  $\epsilon^{50}\text{Ti}$  when normalizing to a <sup>49</sup>Ti/<sup>47</sup>Ti ratio of 0.749766, with a slope of 5.28 ± 0.15 and an intercept of -0.004 ± 0.07, in agreement with 5.48 ± 0.27 and -0.04 ± 0.20, respectively, from Trinquier et al. [2]. Additional measurements on more diverse meteorites are required to understand this correlation.

**References:** [1] Clayton, D. D. 2003 *Handbook of Isotopes in the Cosmos: Hydrogen to Gallium*. Cambridge University Press. [2] Trinquier A. et al. 2009 *Science*, 324: 374–376. [3] Pourmand A. and Dauphas N. 2010 *Talanta*, 81:741–753. [4] Schönbächler et al. 2004 *Analyst*, 129:32–37. [5] Leya I. et al. (2008) *EPSL*, 266: 233–244.