LITHIUM ISOTOPE COMPOSITION AS TRACER OF MAGMATIC PROCESSES AT INTRAPLATE OCEAN ISLAND BASALTS (OIB): A CASE STUDY FROM EL HIERRO (CANARY ISLANDS)

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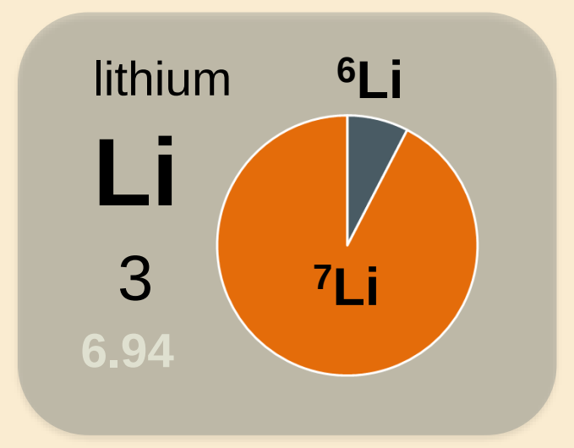
X Congreso Geológico de España
5 - 7 julio 2021 VITORIA - GASTEIZ

01 INTRODUCTION

Isotope geochemistry is a useful tool for understanding how the Earth system works. Together with major and trace elements, radiogenic and stable isotopes provide important clues on Earth's genesis, magma reservoirs and their dynamics.

Lithium systematics



Lithium fractionation is temperature (T) dependent.

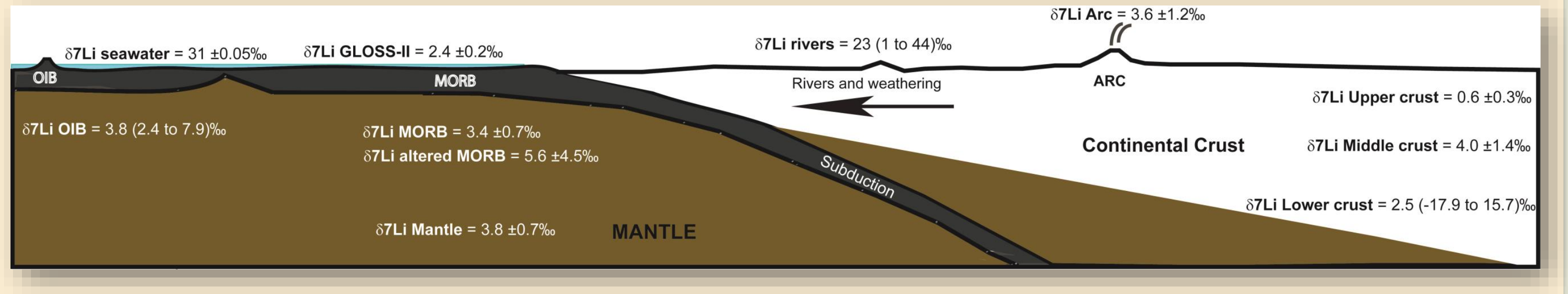
$$\delta^7Li(‰) = \left[\frac{\left({}^7Li/{}^6Li\right)_{\text{unknown}} - \left({}^7Li/{}^6Li\right)_{\text{standard}}}{\left({}^7Li/{}^6Li\right)_{\text{standard}}} \times 10^3\right]$$

High T environments
→ Low fractionation

Low T conditions
→ High fractionation

Lithium (Li) isotopes are proved to be useful indicators of many geological processes, including magmatic cooling histories, weathering, fluids or recycled oceanic crust (1,2).

Fractionation of Li isotopes at magmatic temperatures is considered to be low (1,2). However, some small but systematic isotope fractionation between mantle- or magmatic minerals is observed for Li (3).
Is Li a good tracer of deep and shallow magmatic processes?



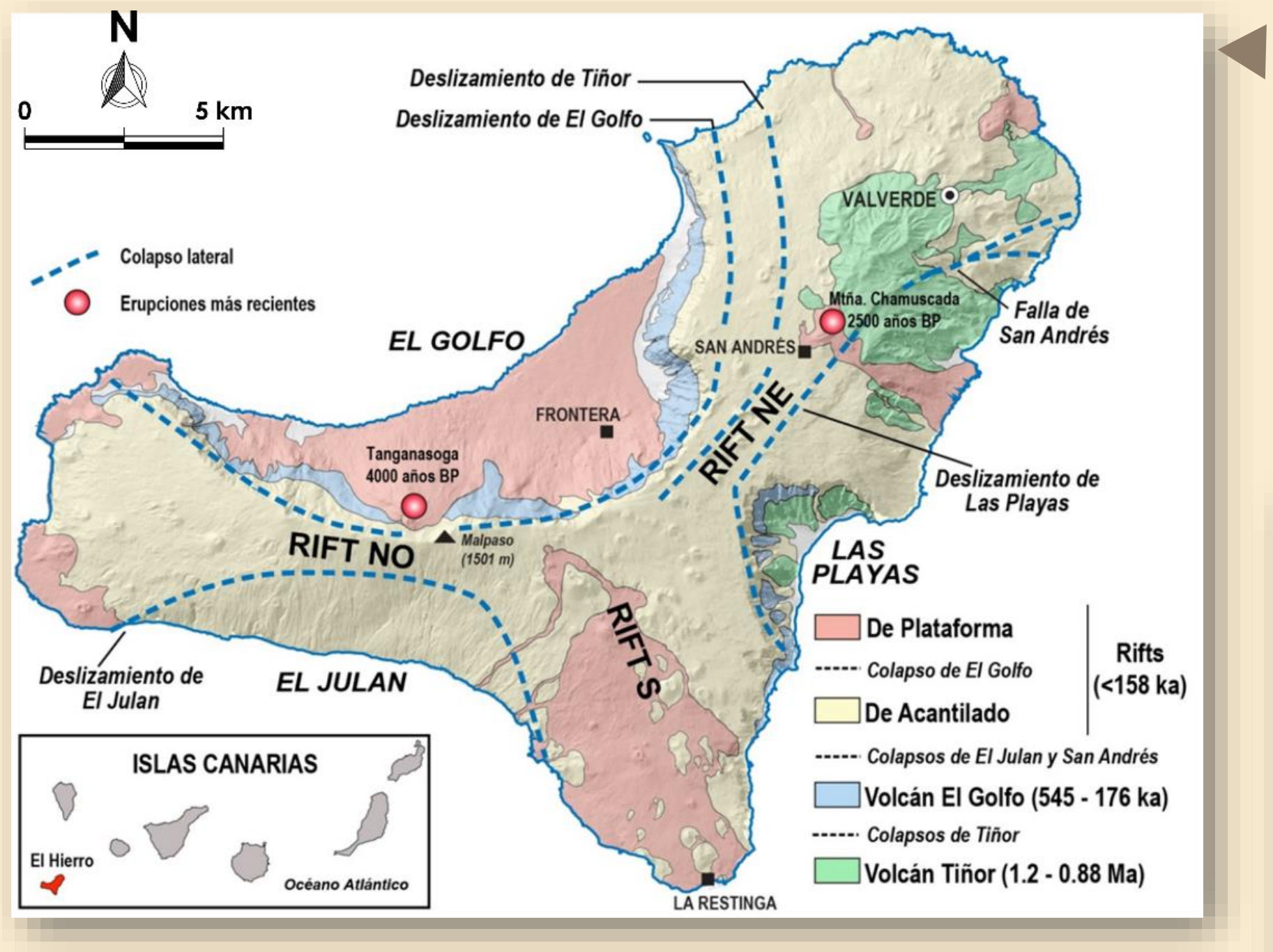
Geochemical reservoirs and cycling of Li isotopes. Values of δ7Li indicated are average values. Values in parentheses are ±1 standard deviations or else ranges of measured compositions. Modified from (2).

We test the application of Li isotopes to shed new light on the magmatic processes involved during the Holocene volcanism at El Hierro (Canary Islands).

02 GEOLOGY OF EL HIERRO

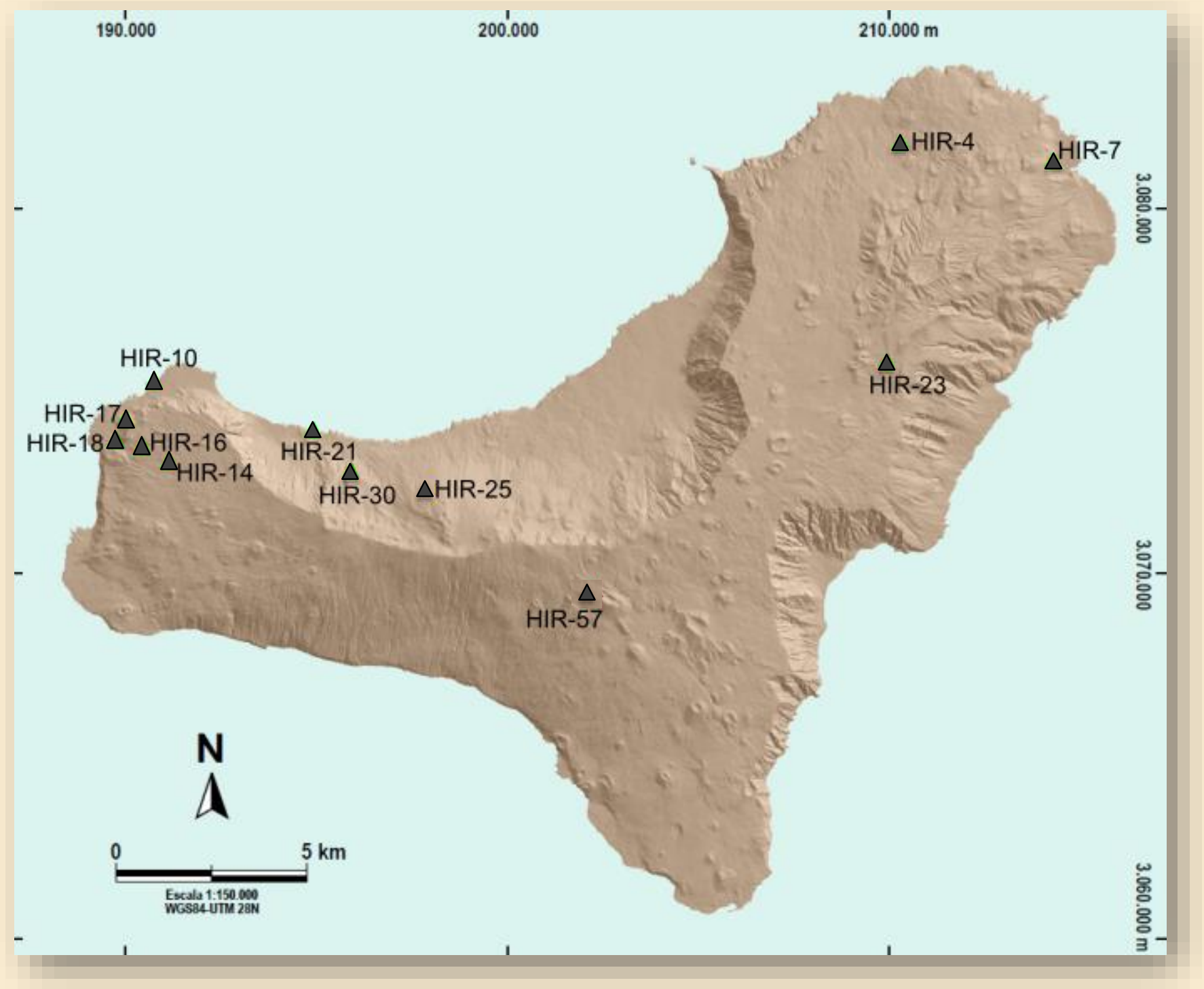
El Hierro, the youngest and westernmost island of the Canarian archipelago, is the emergent area of a 280 km^2 volcanic shield that rises from 4000 m deep seafloor to 1501 m a.s.l. at the center of the island (Pico Malpaso).

Recent subaerial volcanism at El Hierro Island consists of monogenetic volcanic fields associated to three rift-systems converging at the center of the island. This volcanism generated cinder cones, tephra air-fall deposits, and lava flows.



Simplified geological map showing the main volcanic and structural features of El Hierro. Tanganasoga volcano (6.74 ka)(4) is the most voluminous Holocene volcano, whereas Montaña Chamuscada produced the youngest subaerial eruption dated (2.5 ka) (5)

Tanganasoga (top) and Montaña Chamuscada (bottom) volcanoes.



Representative samples of the three-rift system selected for Sr, Nd and Li isotope analysis.

03 METHODOLOGY (Sr, and Li isotopes)

CHEMISTRY PROCESSING → Sample dissolution (HNO_3, HF, HCl) → Chromatographic separation. For Sr and Li: Dowex AG 50W X-8 (200-400 mesh) cation exchange resin. → Loading in Rhenium single (Sr) and double (Li) filaments

ISOTOPIC DETERMINATION (TIMS) →
- Heat up ionization (T= 1030°C)
- Heat up Evaporation (500-800 mA)
- Final T ca. 1030°C
- Peak center of both Li masses
- Focusing isotope signals
- Raising isotope signals (c.a. 1 volt for 7Li)

→ **DATA ACQUISITION**
- Static mode
- Dynamic mode

→ DATA AQUISITION II
After each block of 10 mesures:
-Peak center

Sr and Li isotopes were measured by Thermal Ionization Mass Spectrometry (TIMS). Measurements were performed by using the Finnigan Multicollector Triton TI® at **Osservatorio Vesuviano, INGV**. Sr was measured in static mode, Li was measured in dynamic mode

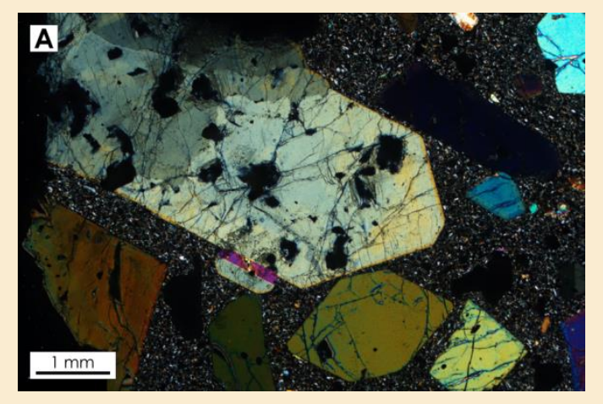
Acknowledgements

Financial support was provided by the Project LAJIAL (ref. PGC2018-101027-B-I00, MCIU/AEI/FEDER, EU). This study was carried out in the framework of the Research Consolidated Groups GEOVOL (Canary Islands Government, ULPGC) and GEOPAM (Generalitat de Catalunya, 2017 SGR 1494).

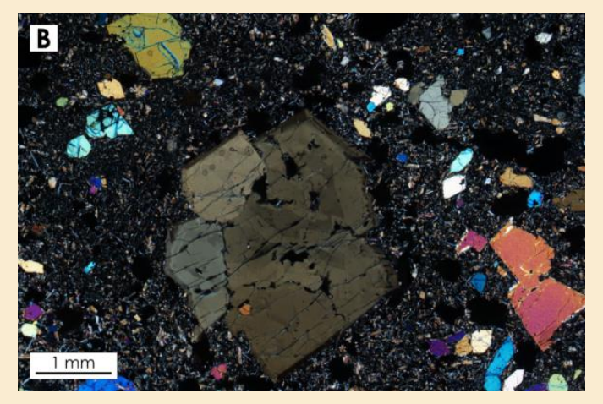
GOBIERNO DE ESPAÑA
MINISTERIO DE CIENCIA, INNOVACIÓN Y UNIVERSIDADES
AGENCIA ESTATAL DE INVESTIGACIÓN
EUROPEAN UNION
European Social Fund
Geochronology and petrogenesis of the Holocene volcanism of El Hierro, Canary Islands
Ref. PGC2018-101027-B-I00
Proyectos del Programa Estatal de Generación de Conocimiento y Fortalecimiento Científico y Tecnológico del Sistema de I+D+i

04 PRELIMINARY RESULTS

Petrography and basic geochemistry

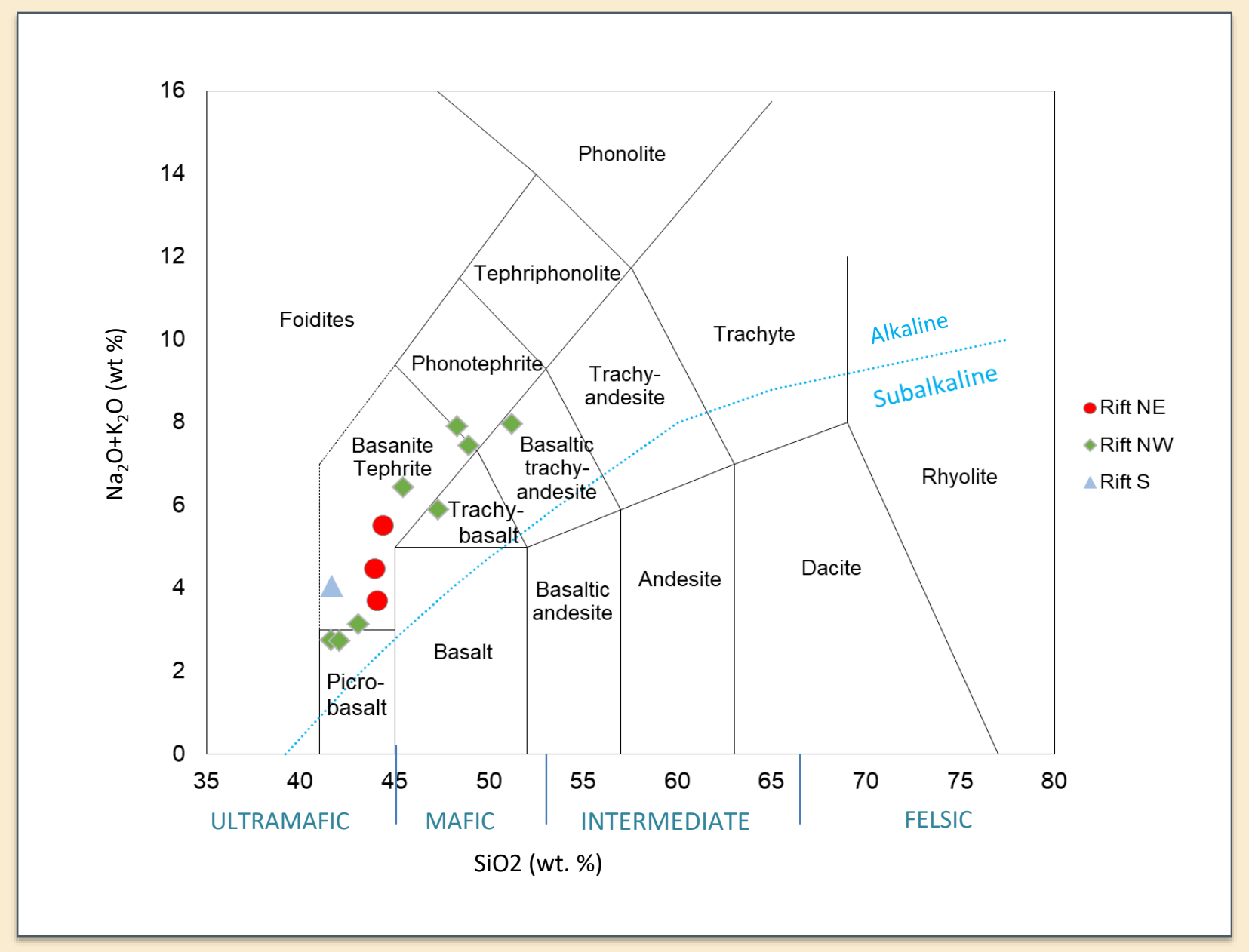


Ankaramitic lavas



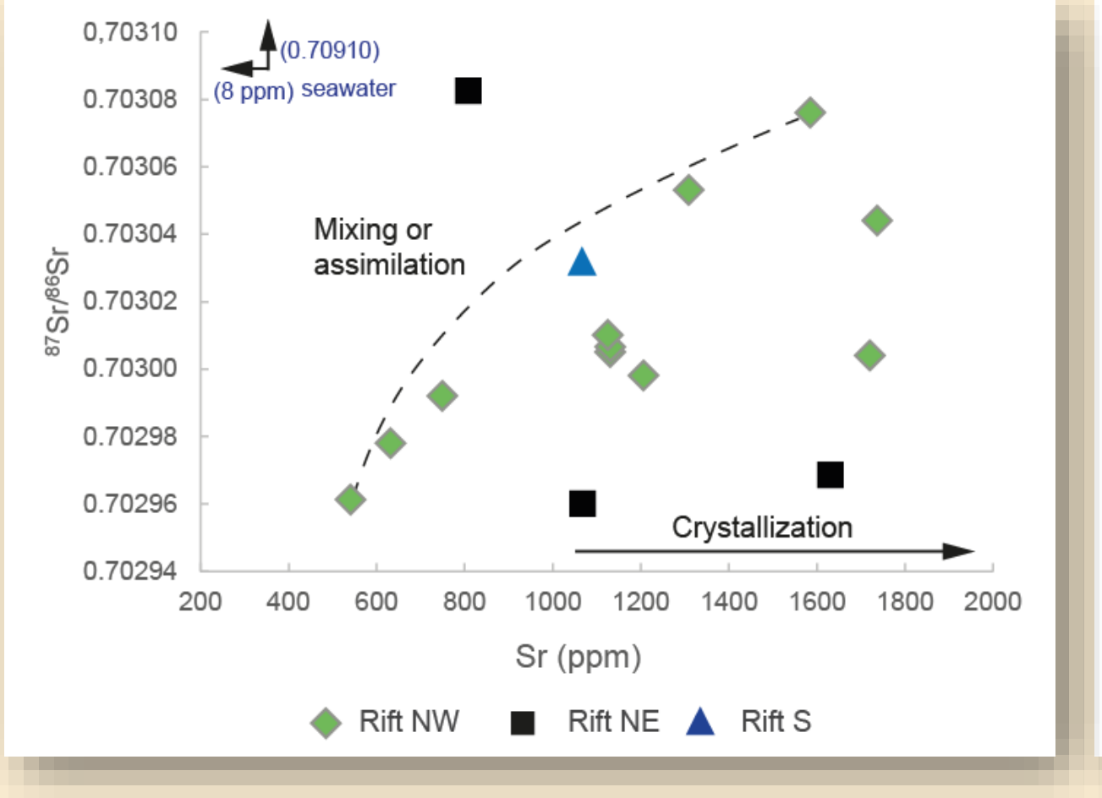
Porphyritic lavas

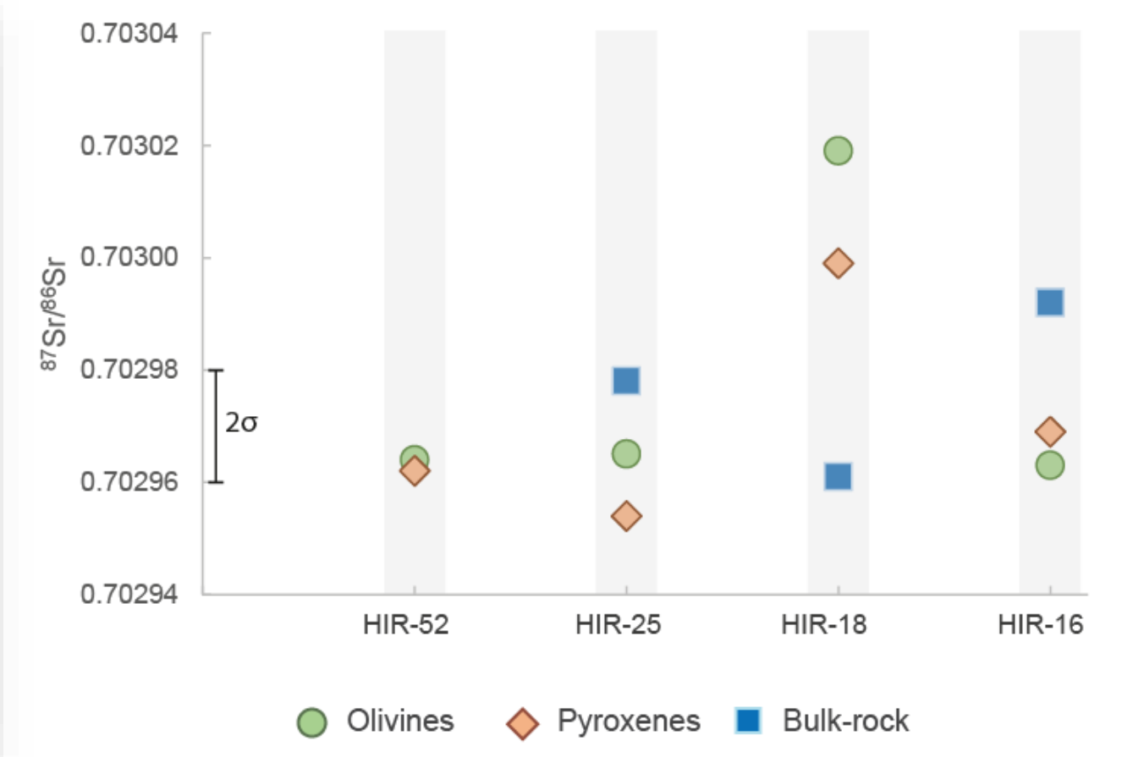
Aphyric lavas



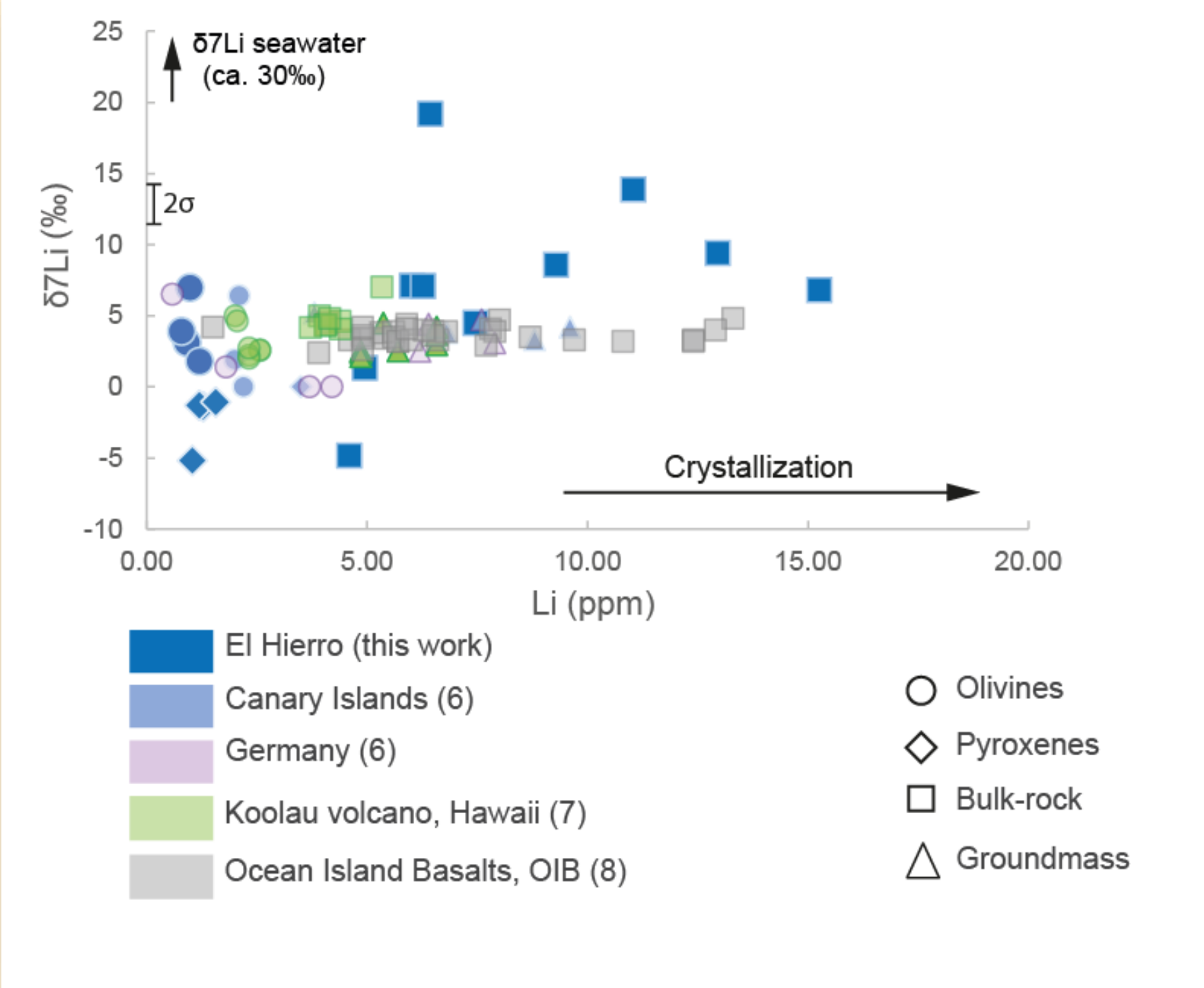
Clinopyroxene and olivine are the best represented phenocrysts. Plagioclase usually occurs in the groundmass. Bulk composition range from picrobasalts (ankaramitic lavas) to phonotephrites and basaltic trachyandesites.

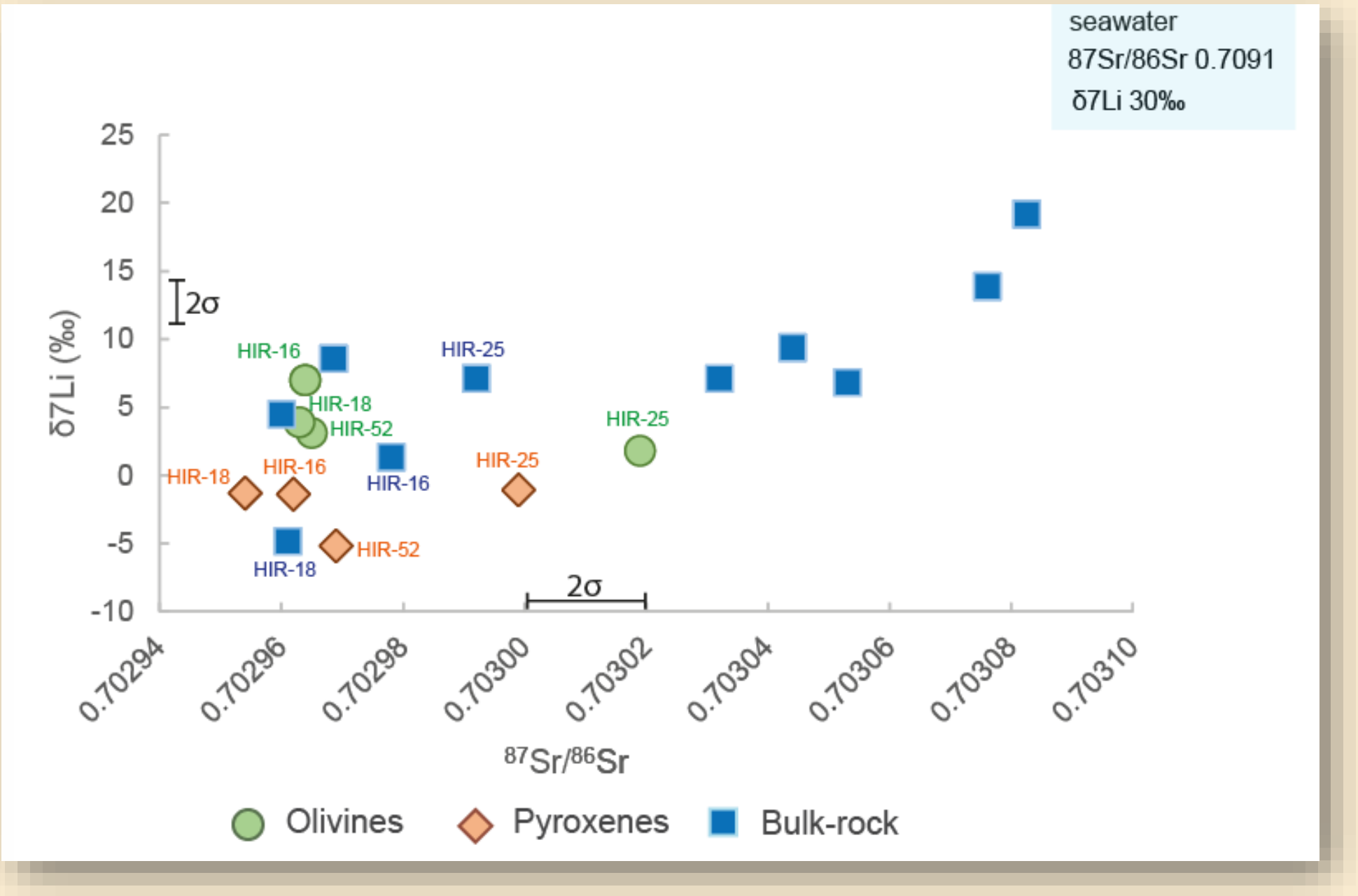
Isotope geochemistry





$^{87}Sr/^{86}Sr$ ratios of bulk-rock and mineral phases are fairly homogeneous within a single sample. However, observed isotopic variations between the whole analyzed samples cannot be explained by fractional crystallization only. Other processes such magma mixing or crustal assimilation are required.





El Hierro bulk-rock samples show higher δ7Li dispersion than mineral phases few samples pointing toward the isotope composition of marine water. Olivines, show δ7Li similar to those reported for La Palma,Tenerife and other OIB regions. δ7Li in clinopyroxenes is slightly low (compared to olivines and the majority of bulk rock) and can be related to isotopic fractionation(6) (due to low T crystallization conditions). Further work is required to explore the usefulness of Li isotopes on defining relatively deep and shallow magmatic processes.

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