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## Introduction

The chemical composition of apatite is a useful tool in magmatic body characterization and a very promising identification marker in sedimentary provenance studies. Apatite halogen contents have been used to decipher different granite types as well as highlighting magma differentiation state or magma mixing. As such, the halogen content measured in sedimentary rocks can be included in the source-to-sink methods toolkit. However, the utility of halogen content in tracking the provenance of sediments remains poorly investigated.

In regions where multiple synchronously-intruded magmatic bodies represent an important source of sediment, source discrimination by detrital geochronology can be challenging due to multiple sources of indistinguishable age. Apatite chemistry, including halogen content, is a promising alternative for provenance analysis. Here we present preliminary results of a study exploring the use of apatite halogen contents in a source-to-sink study. This study focusses on the Caledonian I-type plutons of Scotland and on one nearby modern river sediments.

## Sampling & Methodology

We sampled 5 Silurian-Early Devonian rocks from Scotland near the Great Glen Fault and one stream deposit (Figure 1). Halogen contents were measured on 30 µm-thick thin sections and pucks. The samples were carbon coated before EDS analysis and the C-coating removed before ICPMS measurements. We measured fluorine and chlorine content in apatites on a Scanning Electron Mapping coupled to an Energy-Dispersive Spectrometer (for F) and a Laser Ablation Quadrupole Inductively Coupled Plasma-Mass Spectrometry (for Cl) at Trinity College Dublin. Analytical parameters used are listed below:

	Fluorine	Chlorine
	SEM-EDS	LA-Q-ICP-MS
Facility	Tescan TIGER and MIRA Oxford X-max <sup>N</sup> 150 mm EDS	Photon Machines Analyte Excite 193 nm ArF excimer + Agilent 7900 ICPMS
High voltage	15keV	
Beam current	0.20-0.25 nA	
Acquisition time	30s (TIGER) - 140s (MIRA)	
Number of measure	At least 3 per grain	
Dead time	20-23%	
Standards	Silicates + Durango apatite	
Fluence		2.5 J/cm <sup>2</sup>
Dwell time		250ms for Cl
Repetition rate		30Hz
Ablation time		10s
Standards	Silicates, Durango	NIST612, Bamble, Madagascar, Tioga, 815, McClure, Durango, Kovdor, 815, Tioga
Data Correction required	No	Yes (see below)

Settings used under SEM-EDS and LA-ICP-MS for F and Cl measurement

**Chlorine** content was measured along with other trace elements (eg., U, Pb, Sr, Y, and the REE). <sup>35</sup>Cl background-corrected intensities were normalised to an internal standard and Cl contents were then calculated against a standard calibration curve of <sup>35</sup>Cl/<sup>43</sup>Ca (ICPMS measurements) vs known Cl content (from microprobe measurements) (Chew et al., 2013). In order to distinguish Siluro-Devonian apatites in modern river sediments and use their halogen content as a provenance tool, detrital apatites are U-Pb dated.

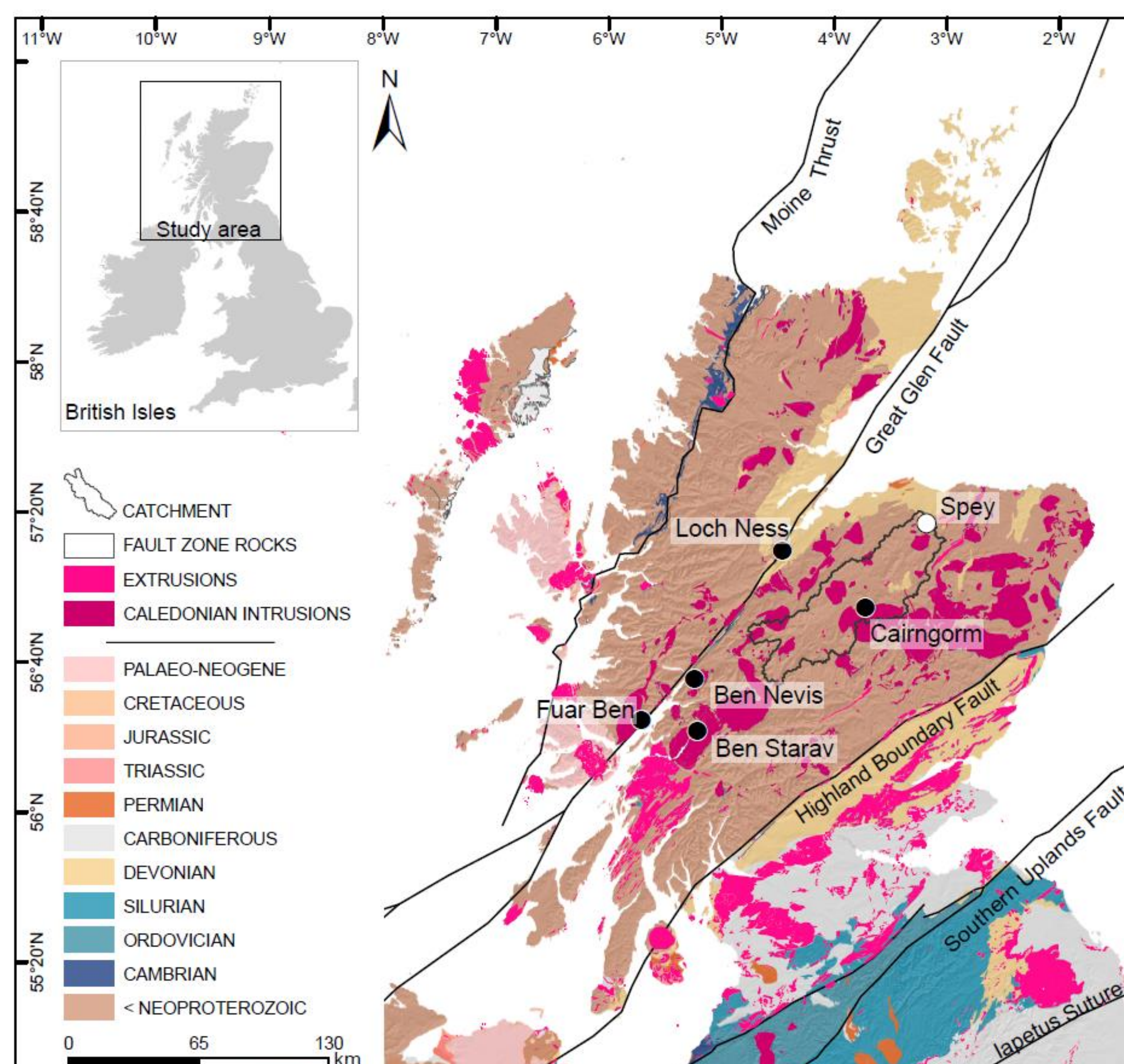


Figure1: Geological map of Britain and Ireland. BS: Ben Starav, CG: Cairngorm, GGF: Great Glen Fault, FB: Fuar Ben, LN: Loch Ness, ML: Mount Leinster.

## Preliminary results

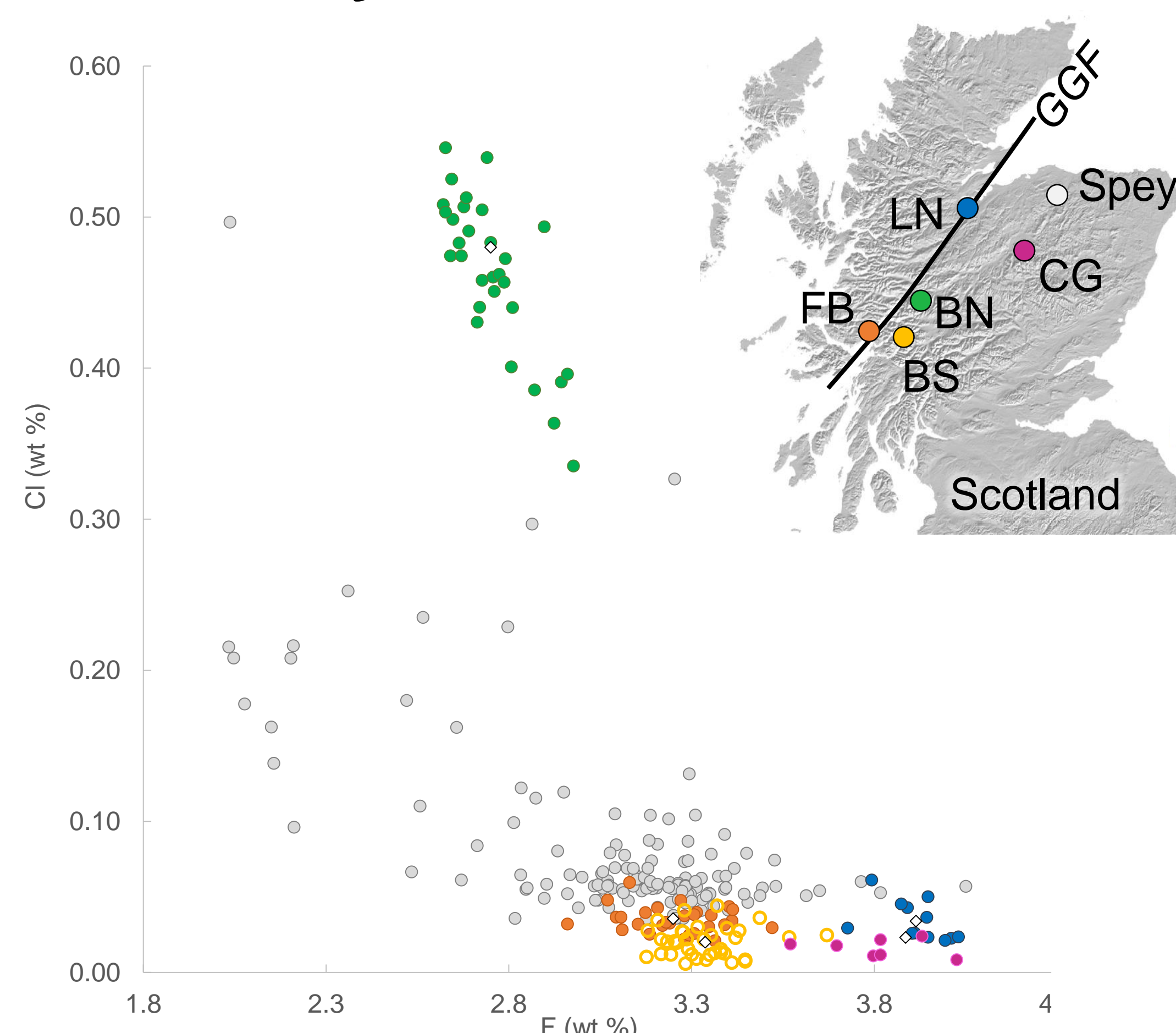


Figure2: Apatite Cl and F contents. Spey grains (grey) will be U-Pb dated to distinguish Caledonian sources.

## Discussion

- Preliminary results **show distinct F and Cl contents between granites of similar age** along the Great Glen Fault in Scotland (Figure 2). These results indicate that the method is more sensitive **in this geological context** than detrital geochronology.
- Detrital apatites show a large variability of halogen content, with either drastically different F and Cl signature than the sampled granites or slightly similar. Small study area would benefit of that variability, but this might become a trickier issue for larger areas.
- Apatite halogen contents may not be the only diagnostic provenance indicator for distinguishing granite sources in the study area. Therefore, apatite trace elements (e.g. **REE patterns**) will also be examined. These trace element signatures may also yield further petrogenetic information on the igneous paragenesis, which can then be integrated with the halogen systematics.

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