Trace elements in quartz: a tool for sediment provenance
Claire Aupart, Damien Desvisme, Philippe Lach, Florian Trichard, Magali Rizza, Pierre Voinchet, Pierre Valla, Gilles Rixhon, Hélène Tissoux

To cite this version:
Claire Aupart, Damien Desvisme, Philippe Lach, Florian Trichard, Magali Rizza, et al.. Trace elements in quartz: a tool for sediment provenance. European Workshop on Laser Ablation (EWLA) 2024, Jul 2024, Ghent, Belgium. 2024. hal-04667768

HAL Id: hal-04667768
https://hal.science/hal-04667768
Submitted on 5 Aug 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L’archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d’enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.
**Quartz** is ubiquitous within continental crust and can be virtually found within all rock types (plutonic, metamorphic, and sedimentary). During erosion, weathering and sedimentation processes, it has a very high preservation potential and is therefore a good candidate to trace sediment provenance and transport pathways. One of the aims of the QuaSIB project is to develop a multi-method protocol for quartz characterisation that can be used to trace the origin of several sediments.

The Strengbacher catchment, selected to develop the method, is relatively small (4 km²) with a relatively simple drainage system. A first step, described in a subsequent section, will be compared in a second step to the quartz signature within river sediments.

**Quartz structures**

The ideal quartz structure is a network of S10 terracotta layers (or cleavage layers). Silicon tetrahedra are arranged in flat sheets parallel to the cleavage layers.

Some of the most common defects in the quartz structure are stacking faults and substitutions: The most common substitutions in quartz are Si⁣/⁴₂⁴ and Na⁺, Si⁺, Al⁺, and Fe⁺ substitutions and intergrowth may cause charge compensation to keep the crystal electrically neutral. This site is often taken by foreign cations such as Li⁺, Na⁺, K⁺, Ca⁺ that can site within the channels.

Defects in the quartz structure are basically linked to various conditions and environment of crystallisation and metamorphism (recrystallisation, deformation, alteration, etc.). It shows that by using complementary methods, it is possible to establish a signature come to quartz with a similar history.

**LA-ICP-MS: Grains vs whole-rock**

- LA-ICP-MS: analysis spot analysis of quartz of whole-rock and sediments samples.
- Batch analyses: 35 samples.
- Single analyses: 9 samples (Li, Na, K, Ca, Mg, Al, Sr, Zr, La, Nd).
- Different elements in separate analyses are complementary.
- No significant effect of quartz purification.
- Roche-M (2009) due to selection quartz type sampling.

**Quartz signatures**

Based on petrology and quartz chemistry, 5 quartz types can be distinguished:
- Sedimentary:
  - Magnetic group 3:
    - Metamorphic
  - Unmetamorphic
  - Pseudomorphs
- Chemical signatures: magnetic group 1:
  - Same intensity faulted
  - Migmatic group 2: deformed gransitic quartz
  - Migmatic group 3: deformed gransitic quartz
- Hydrothermal quartz:
  - Migmatic group 1: deformed gransitic quartz
  - Sedimentary quartz:
    - Migmatic group 2: deformed gransitic quartz
  - Migmatic group 3: deformed gransitic quartz
- Hydrothermal quartz:
  - Migmatic group 3: deformed gransitic quartz
- Sedimentary quartz:
  - Migmatic group 2: deformed gransitic quartz

**Quartz trace elements characterization**

La-ICP-MS were used to determine the quartz trace elements content (Li, Be, B, Na, Mg, Al, K, Ca) in two different samples of quartz (quartz from the study area and quartz from the Metamorphic rocks). The samples were ground and purified quartz grain samples are used for trace elements determination of quartz by LA-ICP-MS.

**Comparison of ESR and OSL**

ESR and OSL are complementary methods. ESR is sensitive to the chemical composition of the quartz, while OSL is sensitive to the physical state of the quartz. The combination of ESR and OSL can provide a more comprehensive understanding of the quartz properties.

**Table 1:**

<table>
<thead>
<tr>
<th>Sample Description</th>
<th>ESR Data</th>
<th>OSL Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metamorphic quartz</td>
<td>Li⁺ Li⁺⁺</td>
<td>Large signal-to-noise ratio</td>
</tr>
<tr>
<td>Sedimentary quartz</td>
<td>Li⁺ Li⁺⁺</td>
<td>Small signal-to-noise ratio</td>
</tr>
</tbody>
</table>

**Figure 1:**

- Quartz grains from different quartz types.
- Comparison of ESR and OSL peak positions.
- Quartz grains from different quartz types.
- Comparison of ESR and OSL peak positions.