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PETROLOGICAL FACTORS CONTROLLING THE GEOGENIC ORIGIN OF HIGH FLUORIDE CONCENTRATIONS IN PRECAMBRIAN AQUIFERS IN CENTRAL BENIN, WESTERN AFRICA

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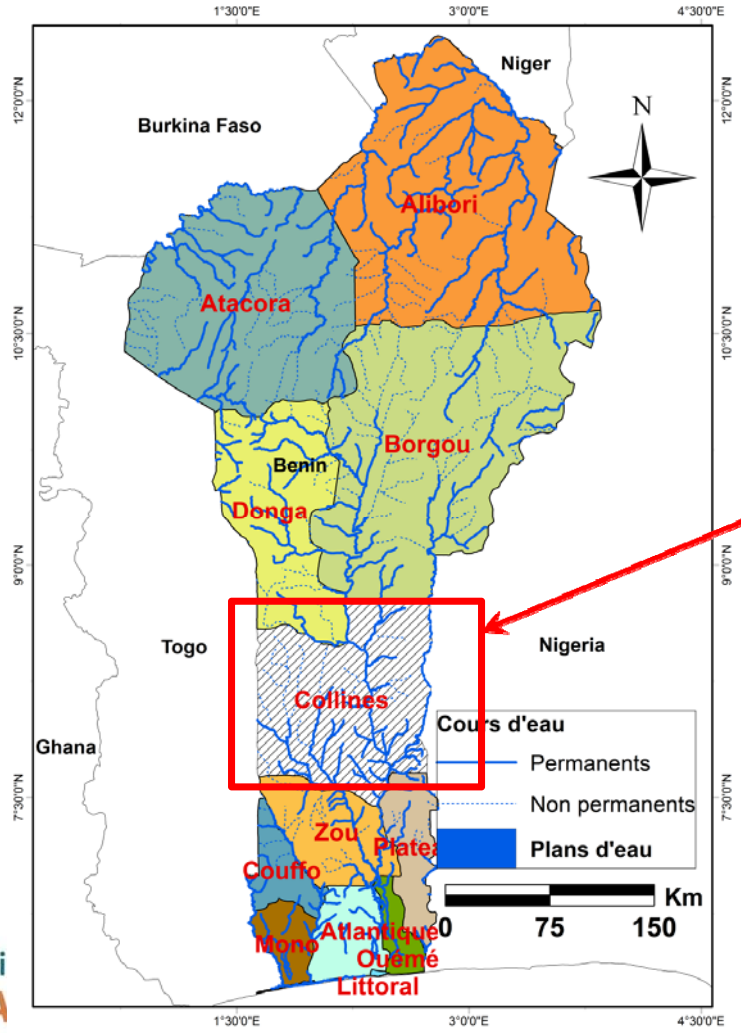
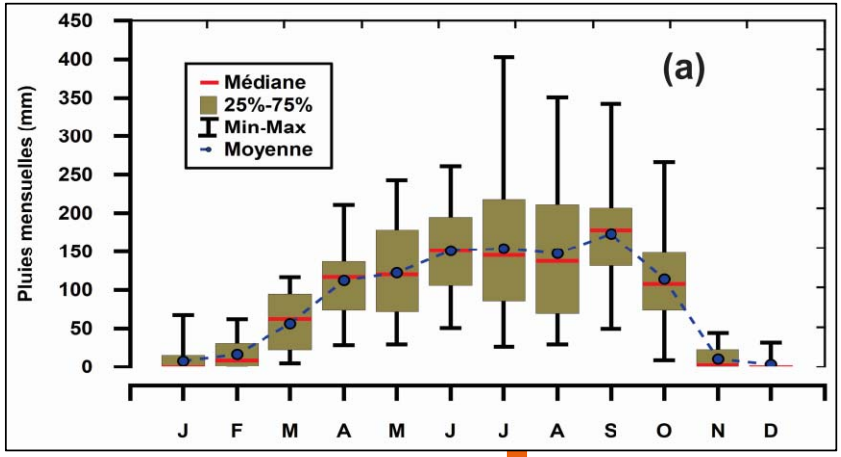
Study area and problematic





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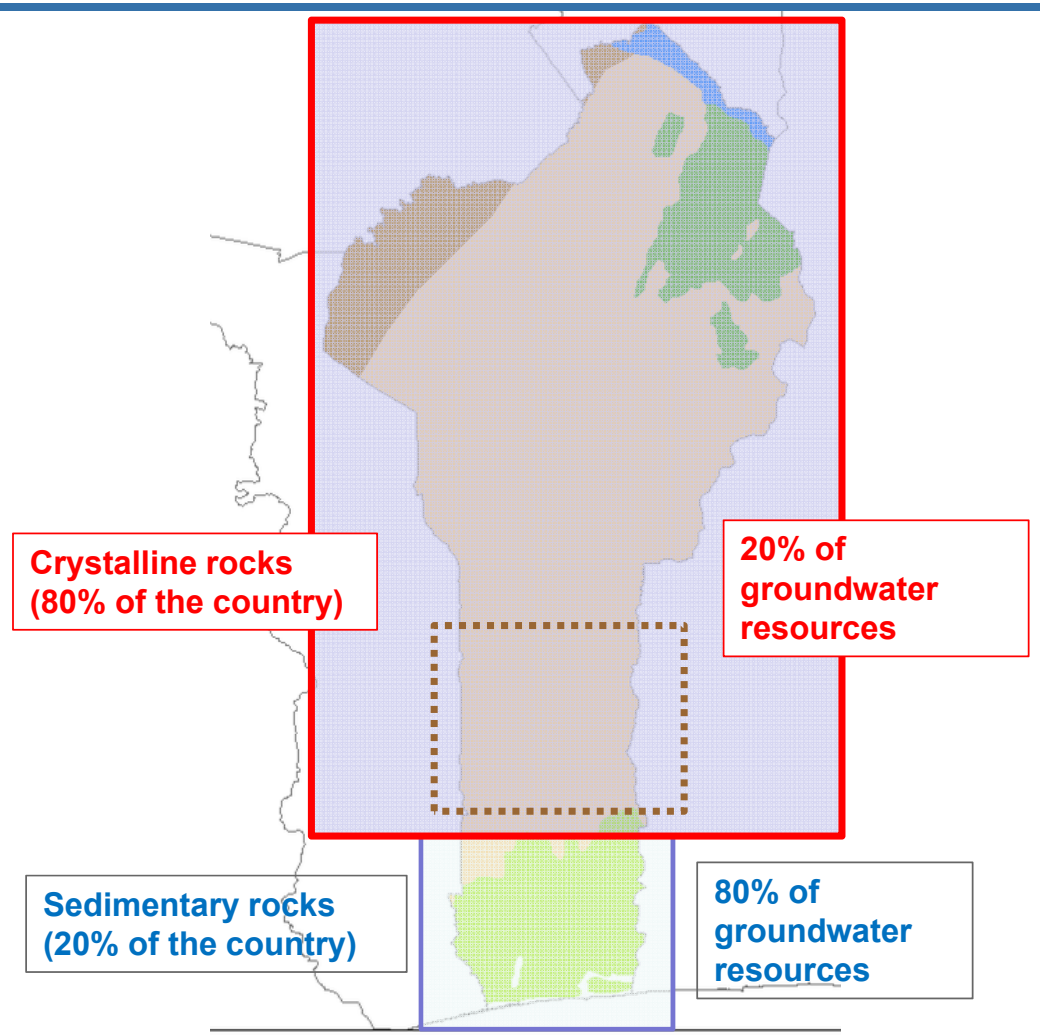
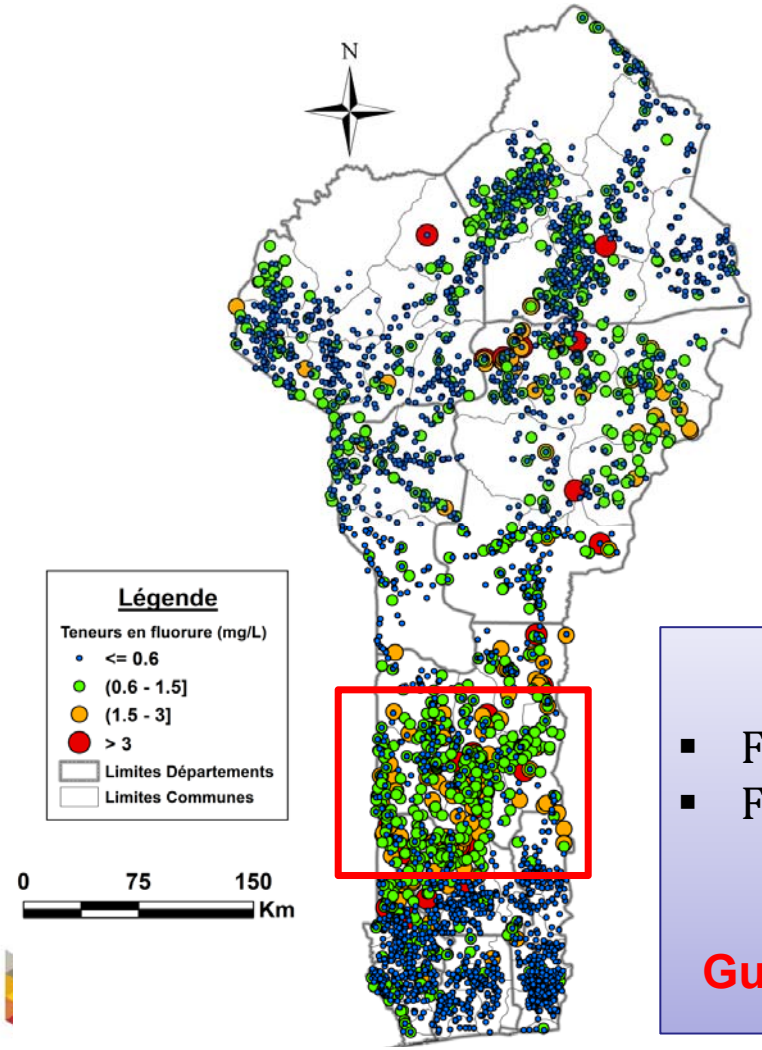


http://earthwise.bgs.ac.uk/index.php/Hydrog%C3%A9ologie_du_B%C3%A9nin

Study area and problematic



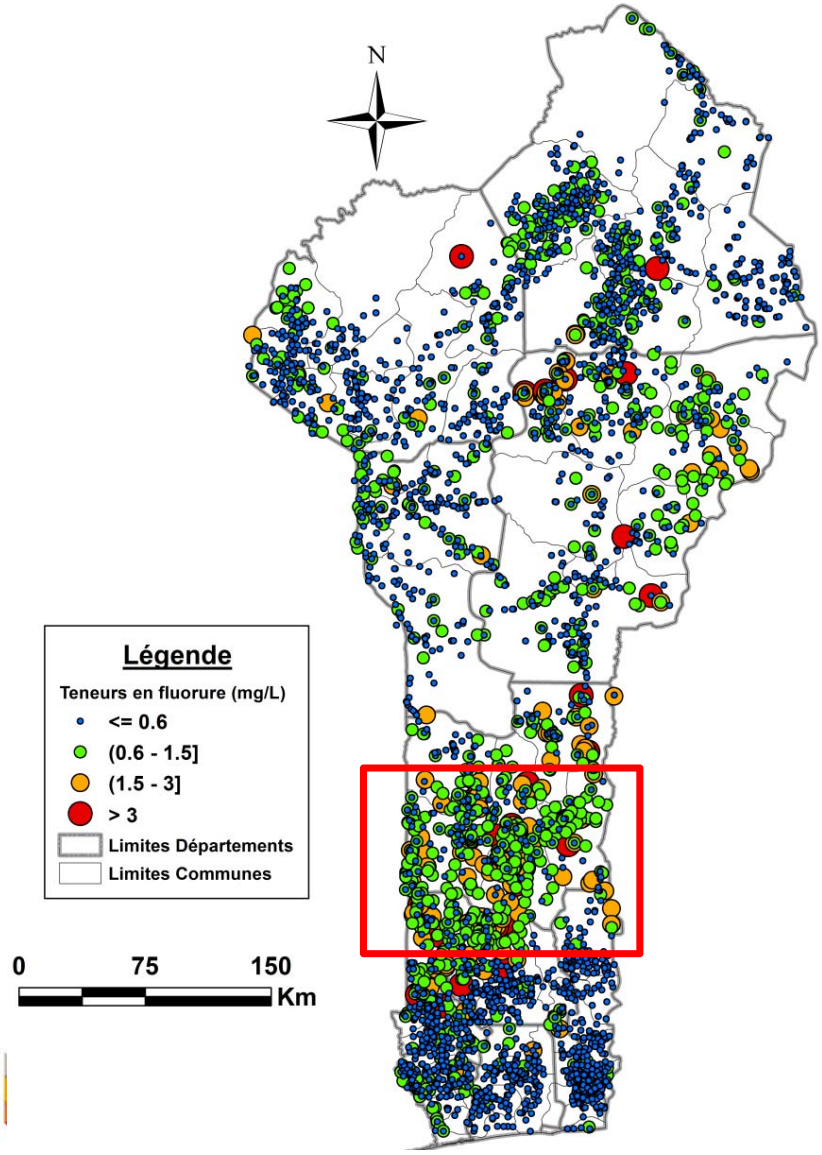
- High fluoride concentrations are found in groundwater
- Health impacts are observed in the population

Health effects of fluoride (F-)

- F^-<0.6 mg/l in water → Dental decay
- F^- >1.5 mg/l in water → Dental fluorosis or squeletal fluorosis

Guideline for F- value in drinking water *(WHO)*: 0.6 - 1.5 mg/l

Objectives of the study



- To determine the main sources of fluorine in the basement and
- To estimate the role of different characteristics (petrography, mineralogy and geochemistry) of the geological layers on the mineralization of the high fluoride (F^-) contents in groundwater

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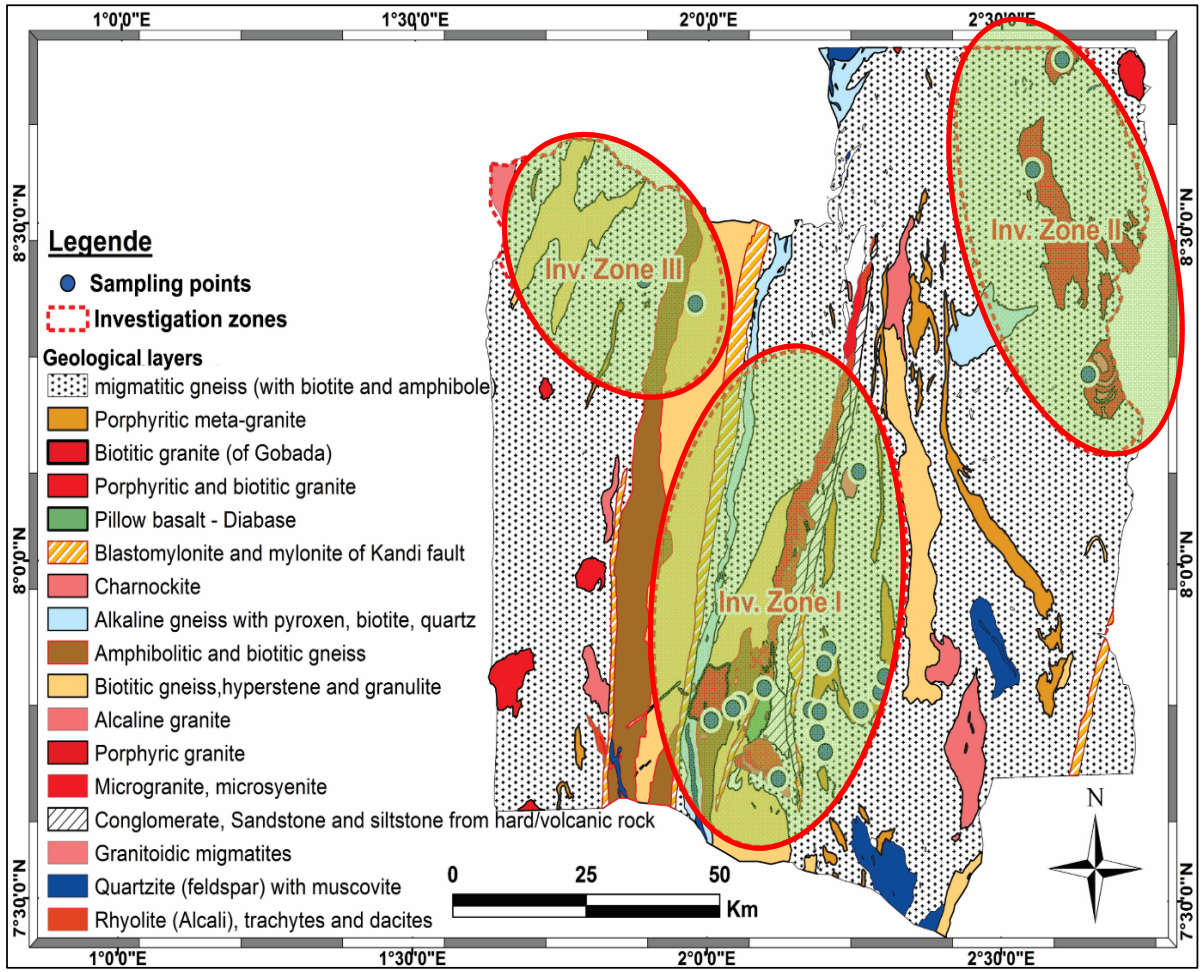
Material and methods

o **Sampling**

35 outcrop rock samples were taken from three sites**.** These sites are referred to as "Investigation Zone (IZ)"

o **Samples analysis and data interpretation tools**

- Thin section for each sample on fresh specimen
- X-ray diffraction on the rock powders :
- Major elements and fluorine contents (wt%) in the minerals
- Mapping of various elements by Electron Microscopy
- binary graphs, multivariate statistics and geostastical analysis to explore the collected data.



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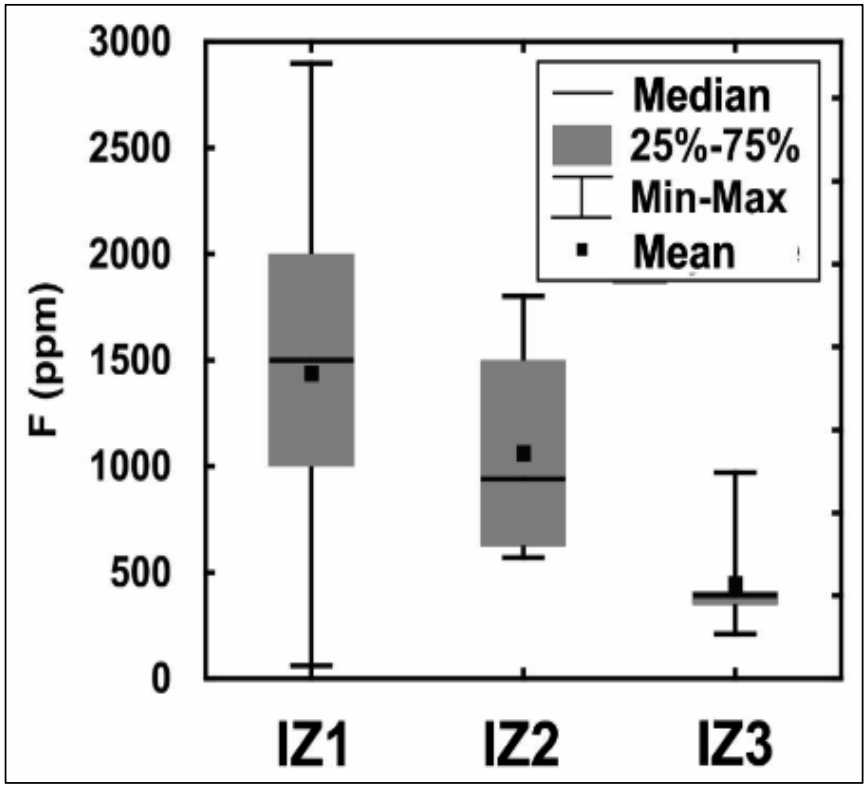
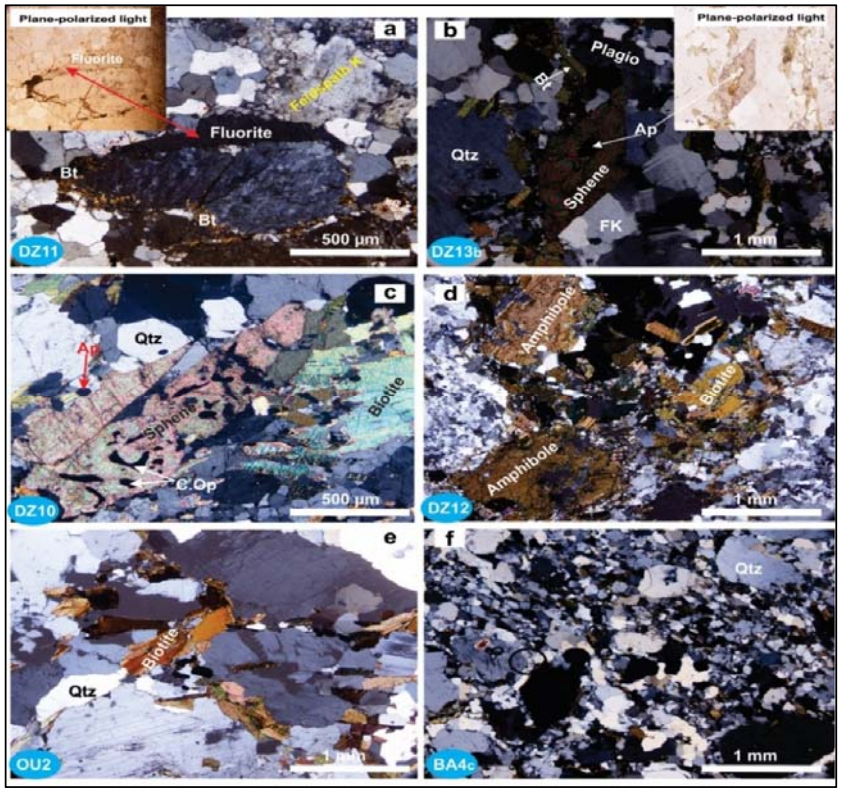
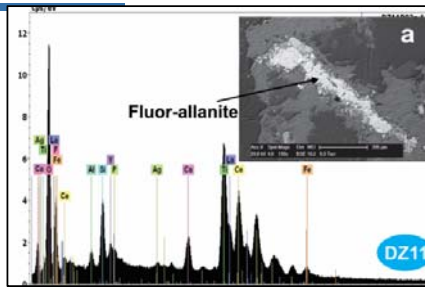
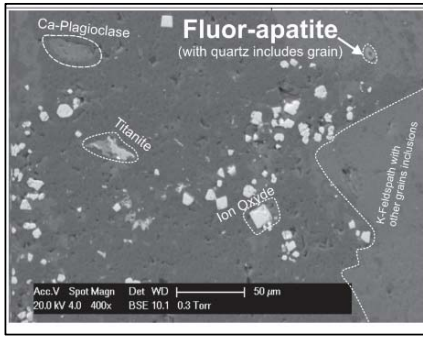
Fluorine content (ppm) in whole rock according to IZ and most of fluorine-rich minerals in the rock









Presence of fluorine rich-mineral as:

- fluorite
- biotite,
- apatite,
- muscovite,
- titanite (sphene)
- chlorite

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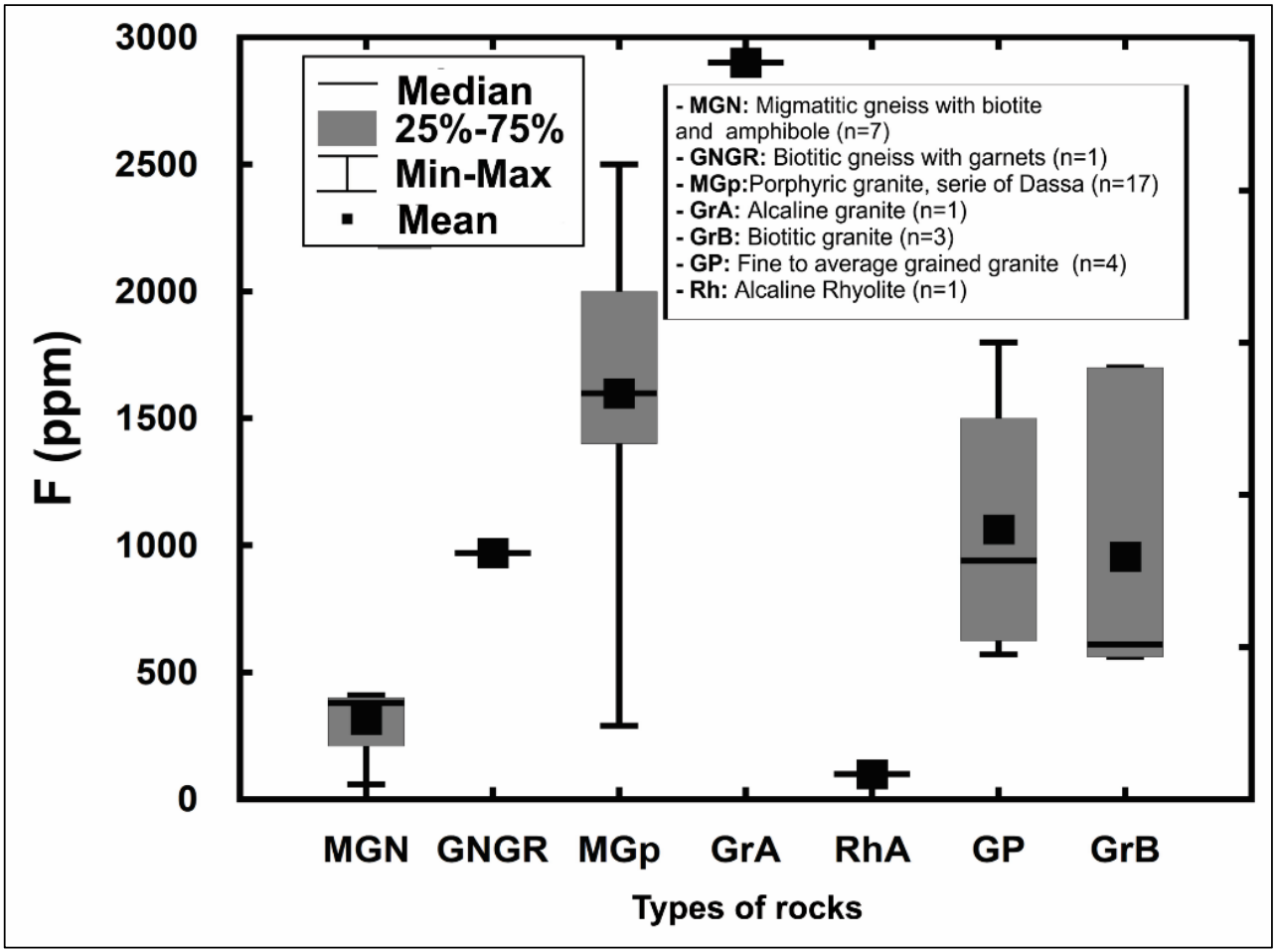
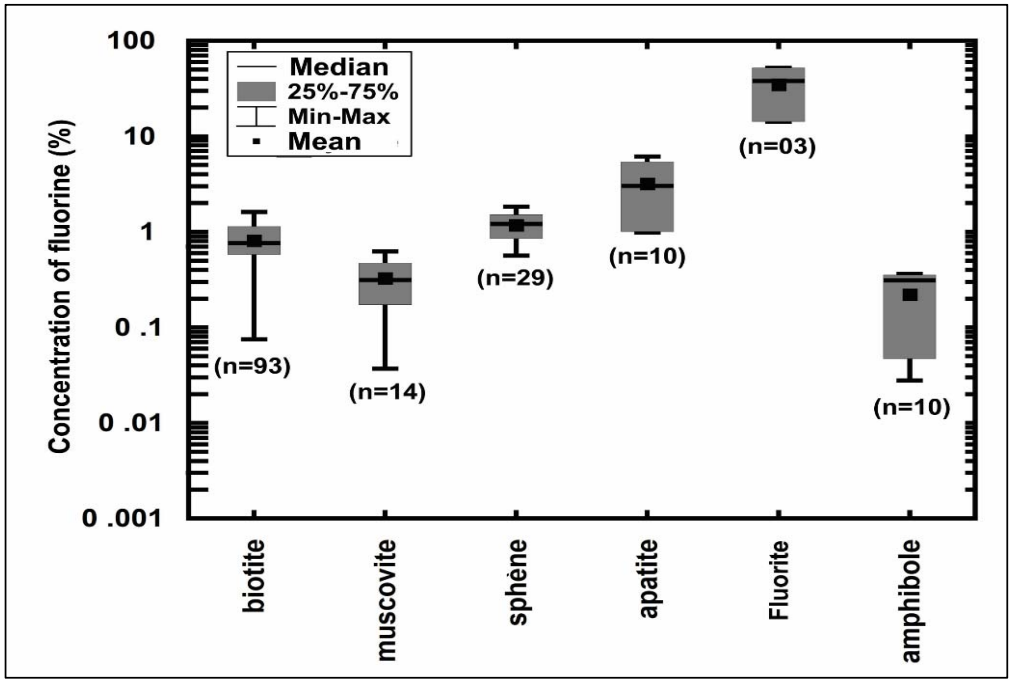
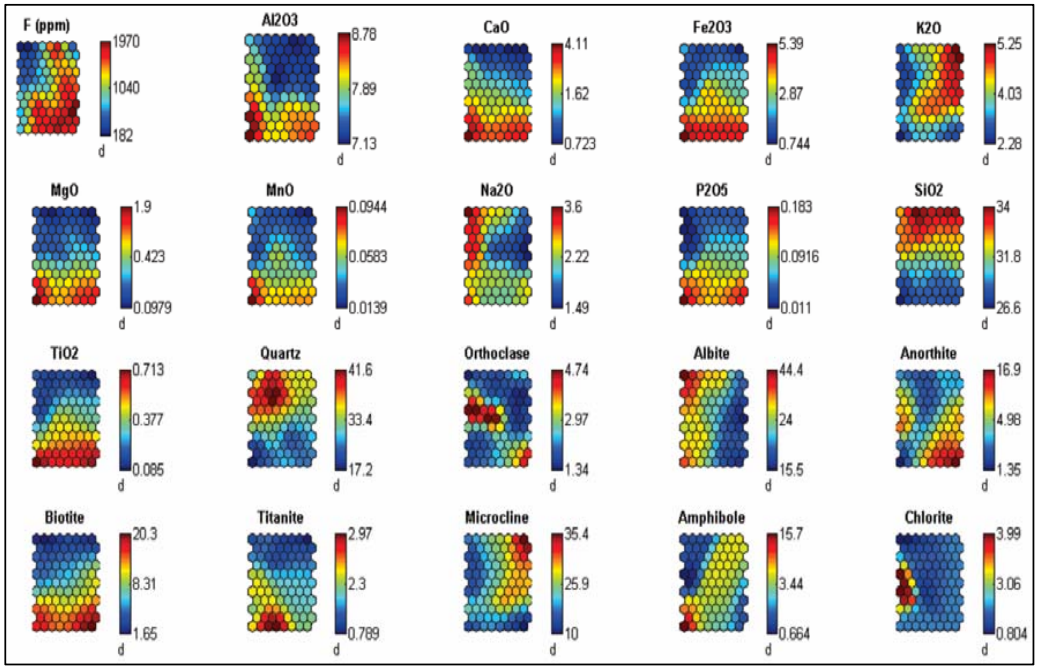
Fluorine contents (ppm) of rocks samples according to their type



Granitic samples have the highest concentrations in fluorine compared to gneiss et migmatites samples

Fluorine concentration of the different fluorine rich-minerals (measurement by electron microprobe

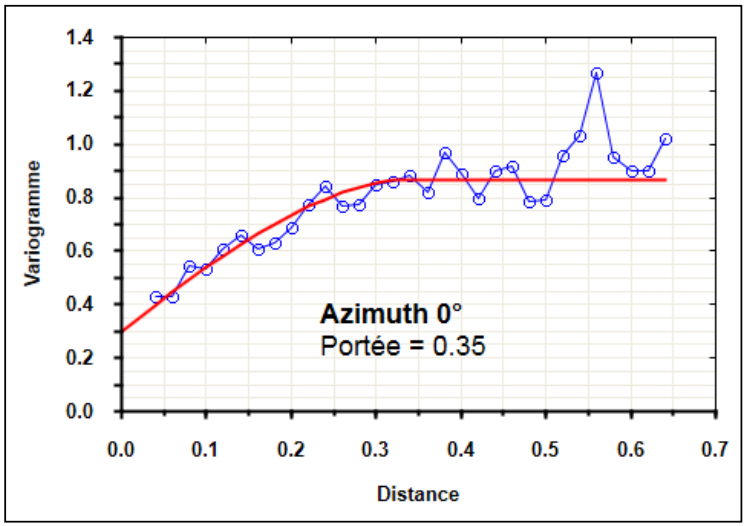


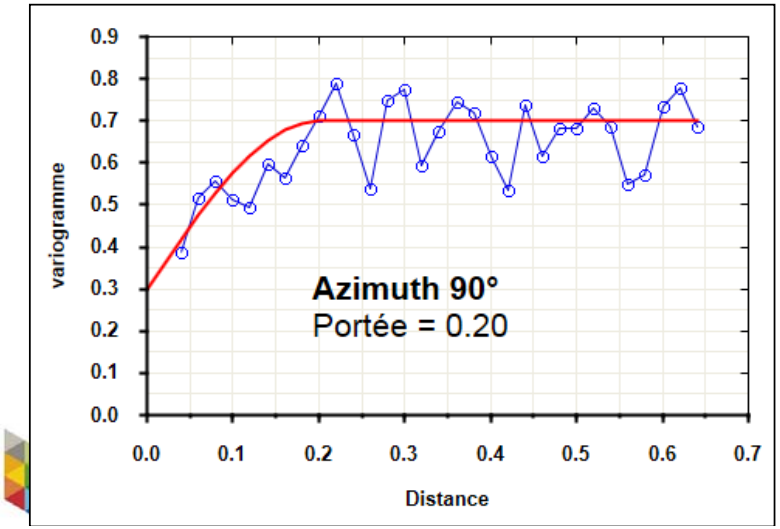


- **Biotite:** High Contribution
- **Fluorite:** Can contribute quantitatively but is less present in rocks

Also…

Proposal of decision support tool for policy-makers based on geostatistical analysis





Modelling of variograms following different directions : 0° ; 22,5° ; 45° ; 67.5° et 90°

- Important nugget effect: Rapid decrease of spatial correlation
- North-South anisotropy coherent with the main geological structures

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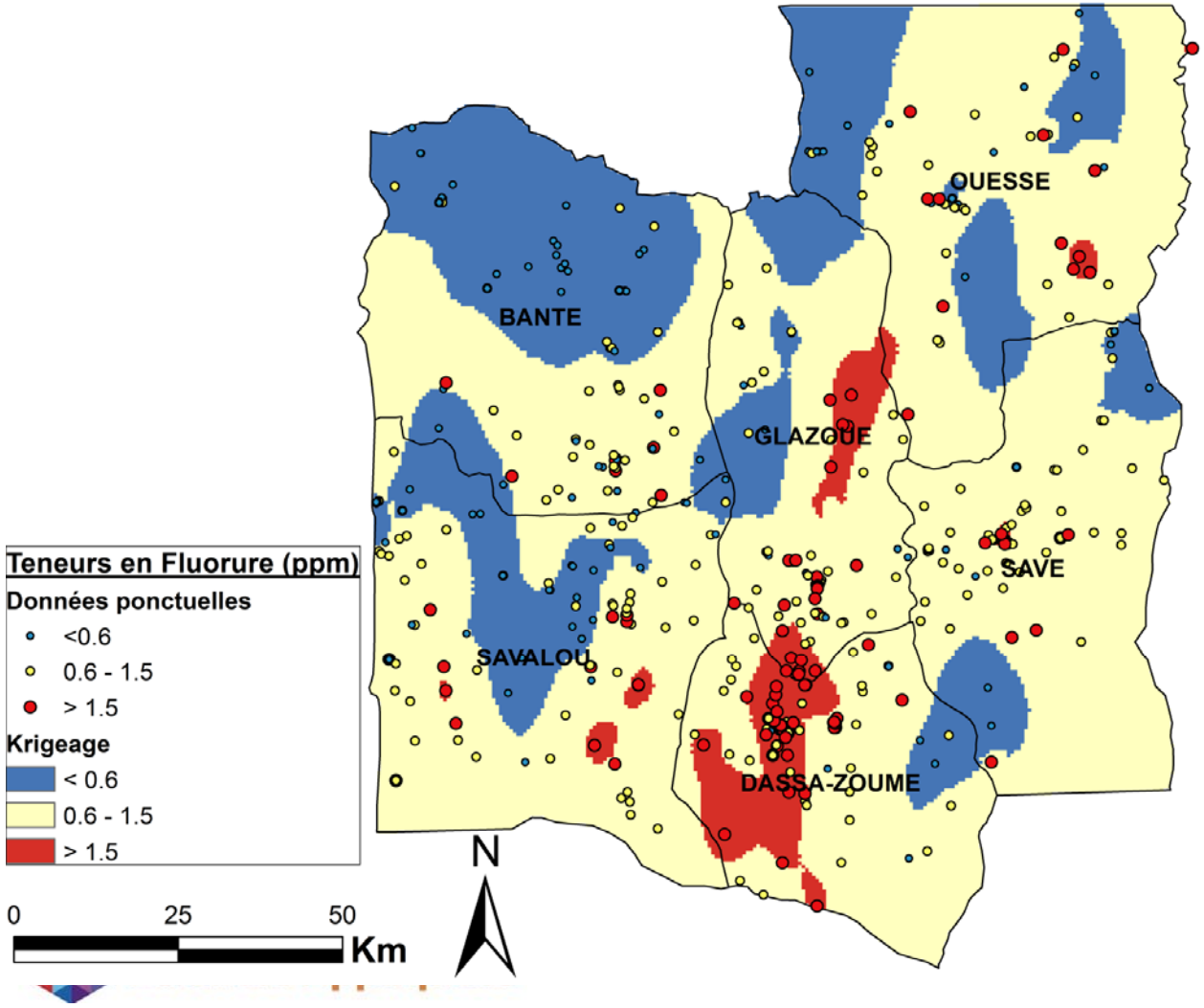
Proposal of decision support tool for poliy-makers based on geostatistical analysis



Map of fluoride estimated concentrations

Patches with high fluoride content mostly in the immediate vicinity of the granitic outcrops in the Dassa-Zoumé area.

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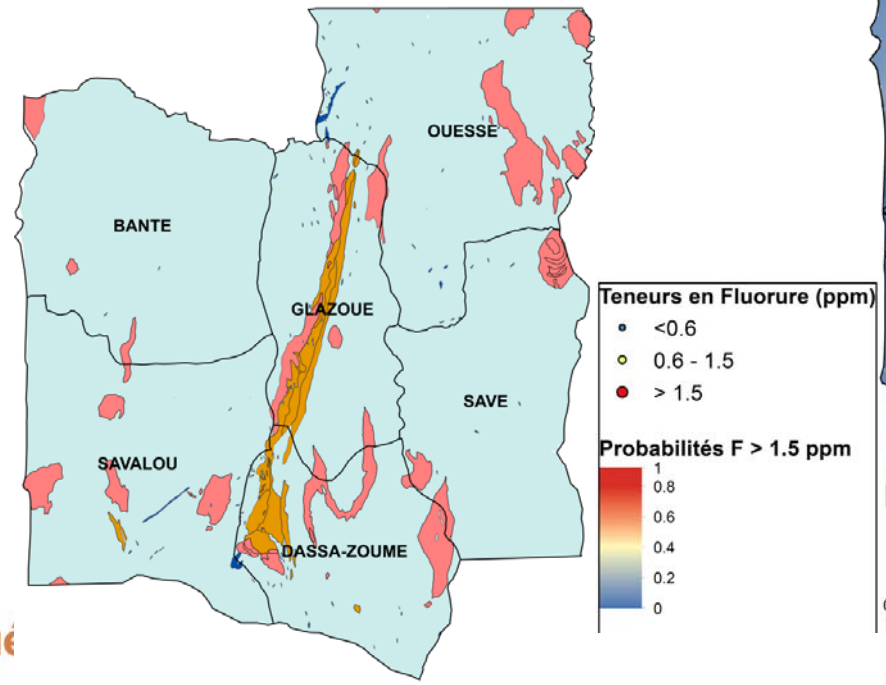
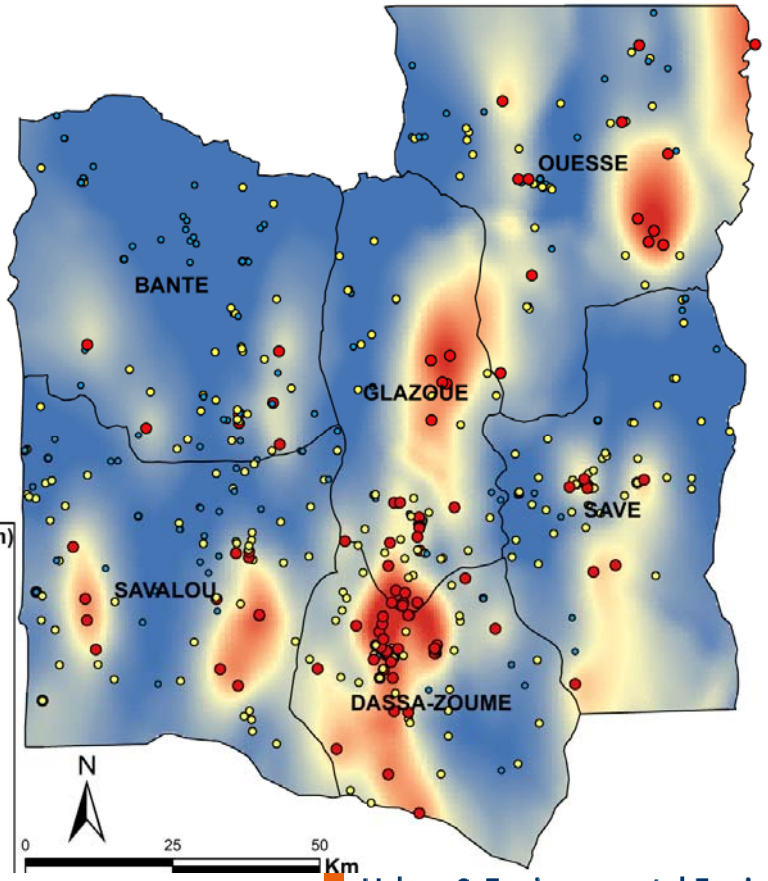
Proposal of decision support tool for poliy-makers based on geostatistical analysis

- Southern area more exposed
- Similarity between areas with high probability and direction of geological structures => strong link between fluoride concentrations in groundwater and geology



Probability map



Conclusions:

This work has allowed to the following conclusions:

- There is a strong link between the spatial differentiation of the petrographic and textural characteristics of the basement rocks and the spatial distribution of groundwater mineralization
- Biotite may predominantly contribute to the presence of fluorine in the rocks but also significantly contribution of amphibole and titanite (sphene).
- The non-silicate minerals such as fluorite and apatite are very scarce in the rocks compared to silicate minerals.

Acknowledgment :

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