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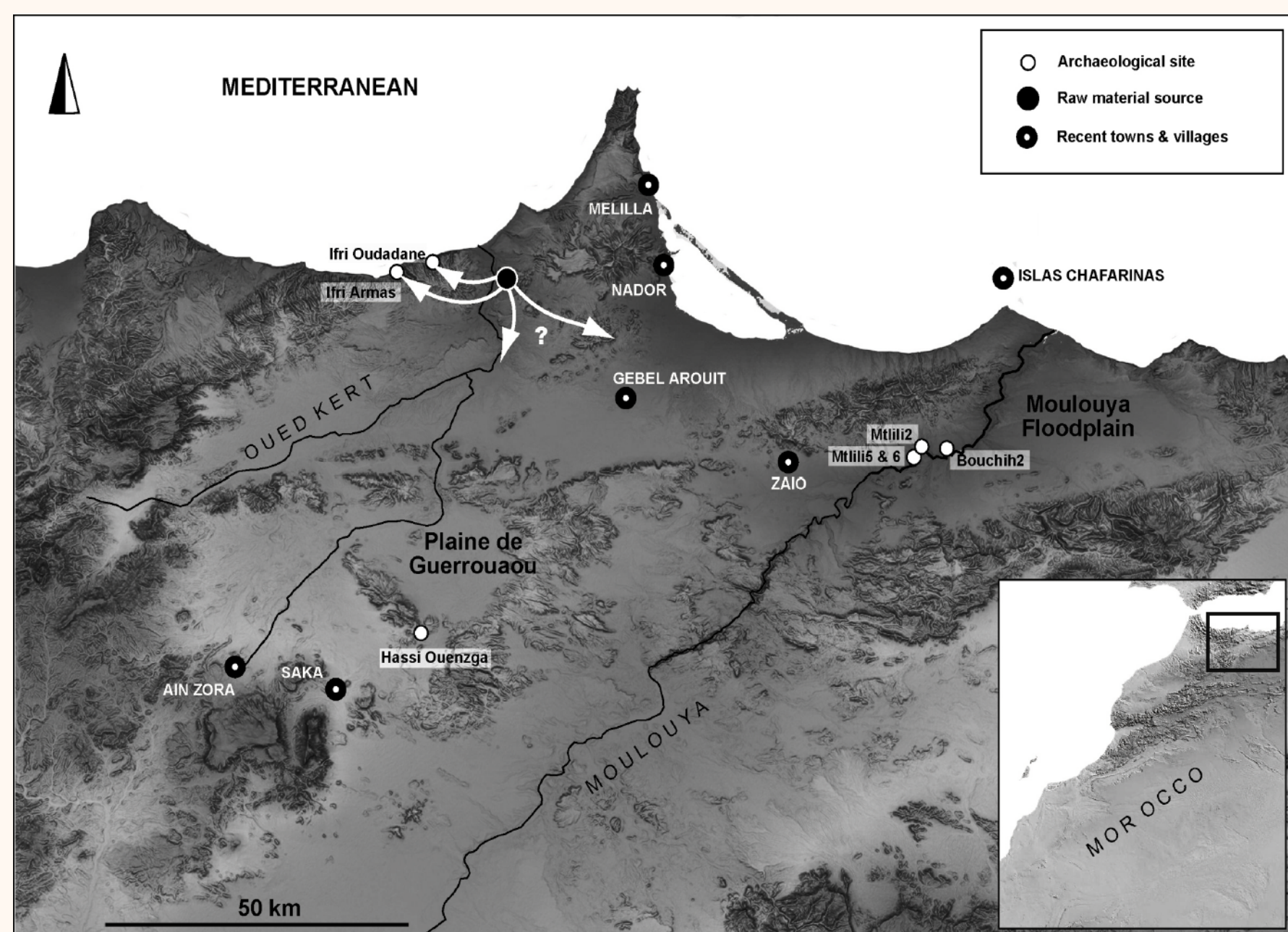
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## Introduction

Within the scope of two German-Moroccan archaeological programs ("Rif oriental" and "Environment and Archaeology in Northeast Morocco - Geoarchaeological research in the Lower Moulouya Valley") pottery used by Epipalaeolithic hunter-gatherer societies and Neolithic groups was found in several excavation sites in Northern Morocco (Linstädter 2008, Linstädter et al. (in prep.)). Mineralogical classification of pottery composition allows for conclusions regarding

- differences in composition
- spread of pottery composition types and use of raw materials.

## Geographic situation



Relief map of northeastern Morocco with excavation sites and raw material source area.

## Excavations

Excavations were carried out in caves as well as open air sites. All investigated sites are located in three different landscape units. For the mineralogical analysis sites were selected from every landscape unit: littoral (Ifri Armas, Ifri Oudadane), interior (Hassi Ouenzga) and Moulouya Valley (Mtilili 2, 5 & 6, Bouchih 2).



Bouchih open air site, Moulouya river bank



Ifri Armas site, cave (arrow) cut open by the new Roudade coastal road

## Archaeological record

The excavations record a Neolithic population using a broad variety of nutritional resources: hunting of marine and terrestrial mammals, fishing, collection of molluscs and keeping livestock. Beside the food rests a huge quantity of different items and remains of their production can be found such as bone and stone tools, adornments from different materials and first of all: pottery!



## Neolithic pottery

The ceramic finds are decorated in various styles, including cordial impressions, and can be dated back to ~ 7500 calBP (14C ages).



Examples of pottery shards from Hassi Ouenzga, displaying decorative elements and relatively coarse grained temper material.

## Mineralogical investigations

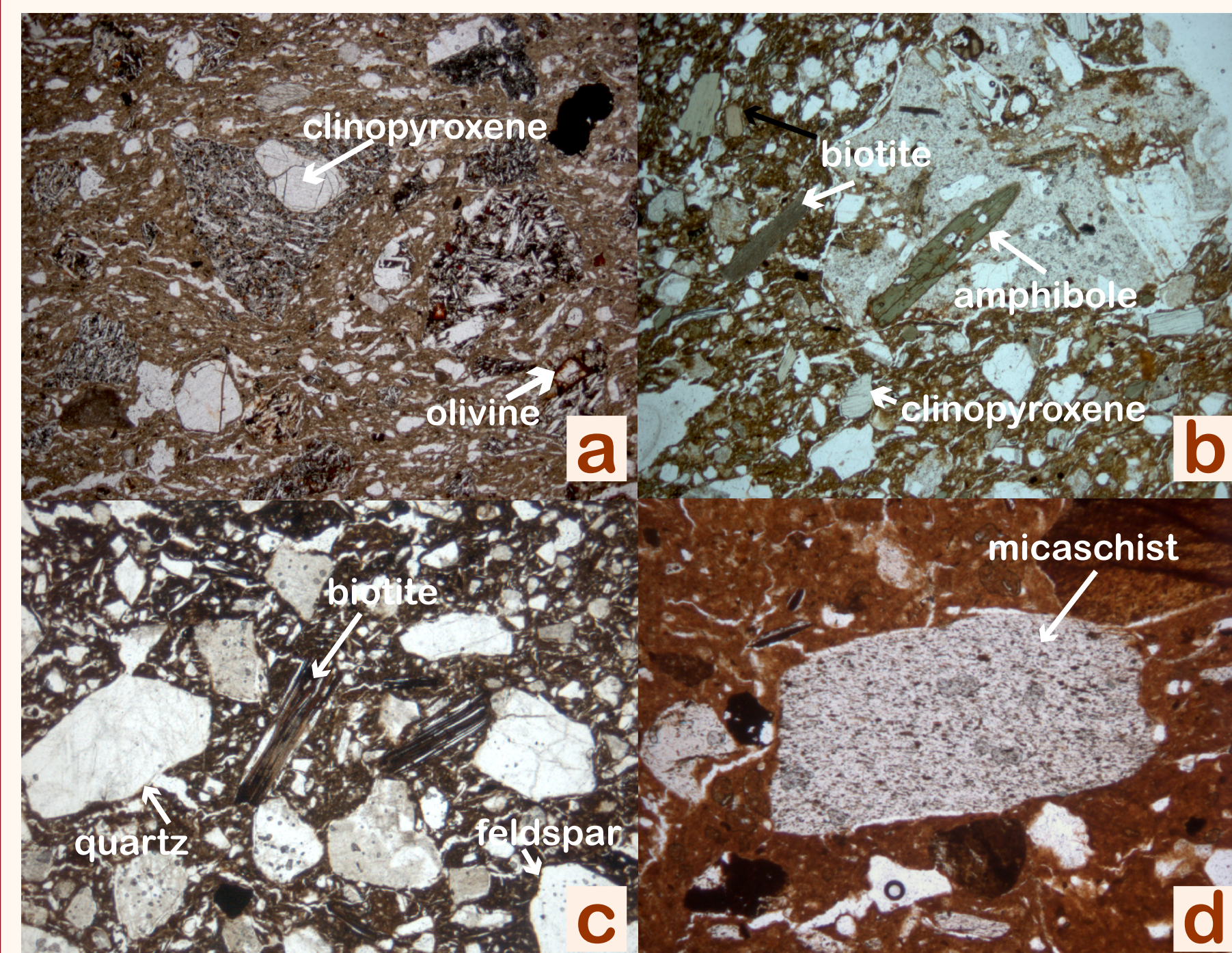
Thin section microscopy and Electron Microprobe analyses give quantitative information on type and composition of temper and paste materials.

Temper grain size:

- 0.01 - 0.7 mm in fine grained pottery up to
- 1.5 - 5.0 mm in coarse grained pottery with coarse grained pottery being more frequent.

Temper material (decreasing frequency order):

- volcanic rock and mineral fragments
- granitic rock and mineral fragments
- metamorphic schist
- limestone
- recycled pottery
- organics (shell debris, charcoal)



Thin section micrographs displaying different temper materials, long edge 5 mm. (a) olivine-clinopyroxene bearing basalt, (b) biotite-amphibole-clinopyroxene bearing andesite, (c) quartz and feldspar from granitic rock, (d) metamorphic schist

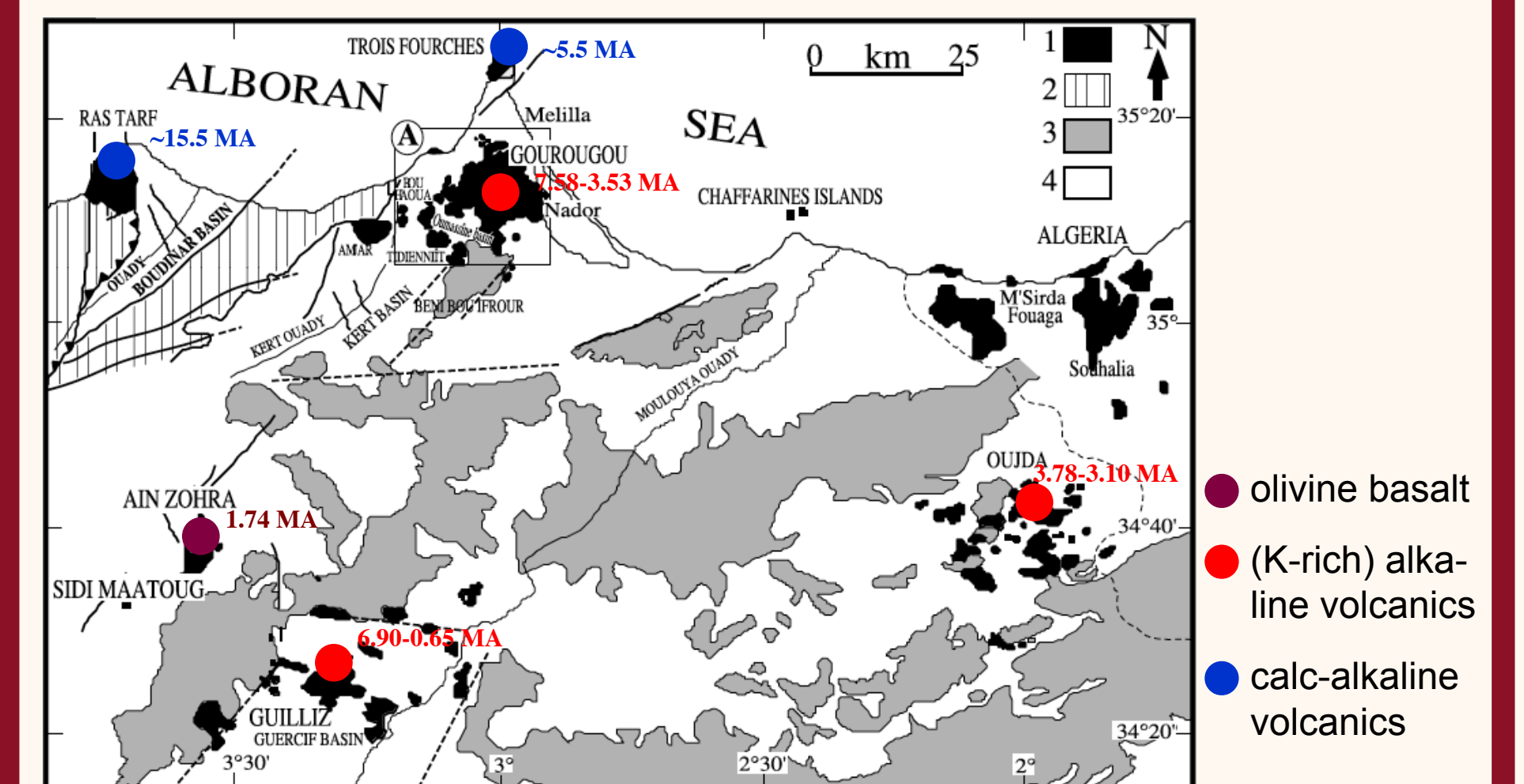
Monogenetic temper material prevails, although mixtures of different rock types do occur, indicating a sedimentary origin of the temper material in a catchment of variable lithology. Except for the olivine-bearing basalt, all different temper materials are observed at all sites. Only the open air sites at the river Moulouya with their reduced inventory show a limited variability. Of special interest is the pottery type with mm-sized biotite flakes, confer an attractive glint to the jars. →

|               | N  | OI-Basalt | Cpx-Andesite | Bio-Hbl-Cpx-Andesite | Metamorphic Schist | Granite | Carbonate |
|---------------|----|-----------|--------------|----------------------|--------------------|---------|-----------|
| Hassi Ouenzga | 41 | ●         | ●            | ●                    | ●                  | ●       | ●         |
| Ifri Armas    | 9  |           | ●            | ●                    | ●                  | ●       | ●         |
| Ifri Oudadane | 10 | ●         | ●            | ●                    | ●                  | ●       | ●         |
| Moulouya      | 4  |           |              | ●                    |                    | ●       | ●         |

Temper materials observed in pottery from different sites, N number of analysed fragments.

## Sources of raw materials

While granitic rocks are very scarce in this area, mafic to intermediate volcanism is widespread. Metamorphic schists occur in the coastal area North of Mont Amar (Rifian thrust units).



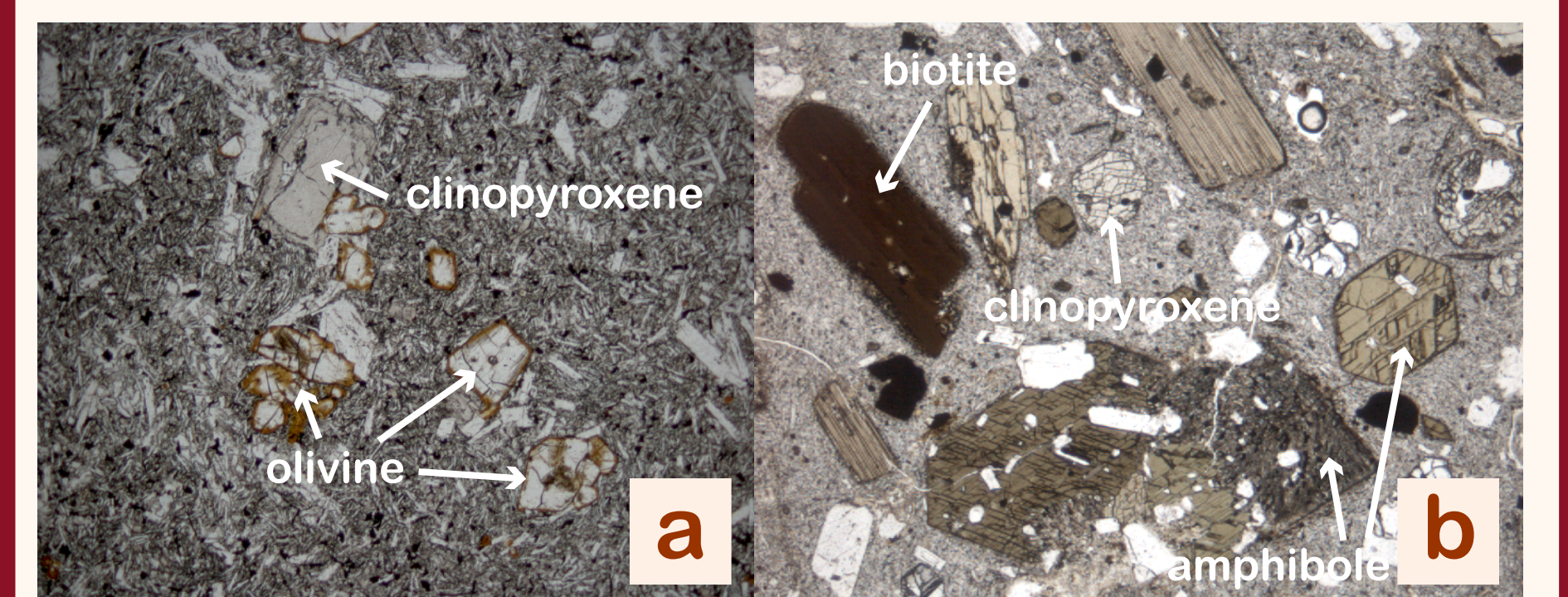
Simplified structural sketch map and volcanism location in Eastern Rif - Miocene and Pliocene-quaternary volcanism, 2 - Rifian thrust units, 3 - foreland, 4 - sedimentary basins (El Bakkali et al. 1998)



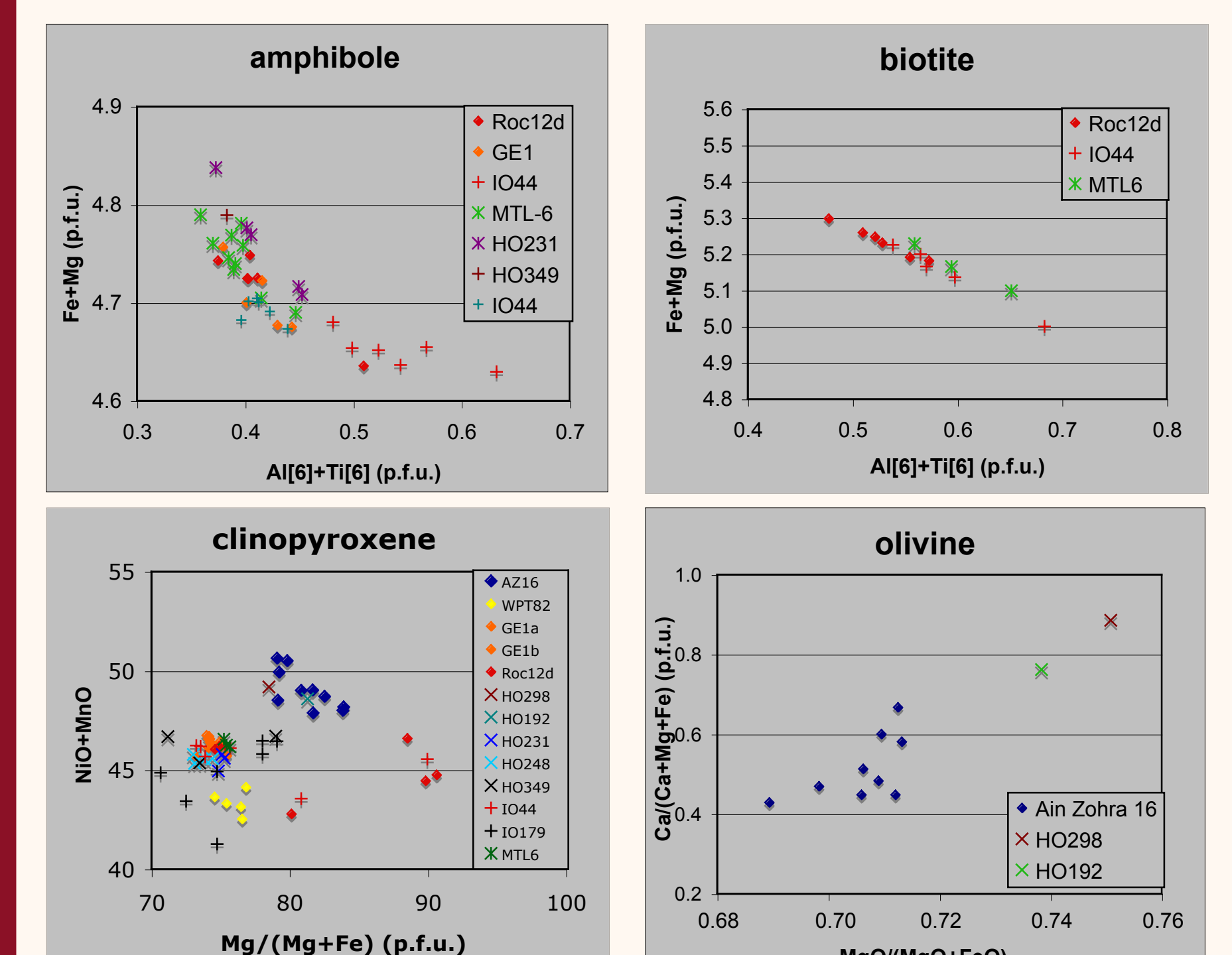
Volcanic landscape at lamorene Ol-basalt flow at Ain Zohra

## Results

Rock samples from Ain Zohra (olivine basalt) and Mont Amar (biotite-hornblende-clinopyroxene bearing andesite) contain the same mineral associations as observed in some pottery fragments. Preliminary compositional data suggest that biotites and amphiboles observed in pottery could be derived from volcanics of type Mont Amar (Roc 12d) while the provenance of other raw materials need further investigation.



Thin section micrographs of olivine basalt, Ain Zohra (a) and biotite-amphibole-clinopyroxene bearing andesite, Mont Amar (b), long edge 5 mm. Compare (a) and (b) of center column.



Electron Microprobe analyses of characteristic minerals in rock samples (◆) and pottery.

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