# PS Volcanic Glass Transformation Types and Their Relationship with the Basin's Parameters: A Case Study of the Rupea Tuffs (Transylvanian Basin) and Govora Tuffs (Dacian Basin)*

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## Abstract

Tuff is a type of pyroclastic rock made up of small sized particles (a diameter of less than 2 mm): vitric ash, crystal ash, and lithoclasts. At 25$^{o}$C and 1 atm. volcanic glass is unstable; this determines the devitrification of the amorfous matter. The pyroclastic deposits show high permeabilities and porosities that allow water circulation, which results in the transformation of the glass into zeolites and clay minerals. Volcanic tuffs in Romania show a riodacitic composition, are of Badenian age and were deposited in the Miocene molasse units in Romania. Usually, riodacitic glass is initially transformed into an alumosilicatic gel; the next transformation steps are: clay minerals, zeolites, analcim and, finally, potassium feldspars.

This paper is an attempt to qualitatively determine the salinity and pH of the Transylvanian Basin and the Dacian Basin (former parts of the Paratethys Basin) during the Tortonian (depositional moment of the Rupea tuffs and Govora tuffs). The method used is X-ray powder diffraction. The results show different transformation patterns which could be interpreted as the response of the vitrified material towards the basin's parameters.

The equipment used for the X-ray powder diffraction method was the X'Pert Pro MPD Panalitycal diffractometer which is equipped with a goniometer, an X-ray tube and a detector slit (a Geiger Muller counter). The scan parameters were: Start Position [°2Th.]: 3.0167, End Position [°2Th.] :119.9937, Step Size[°2Th.]:0.0170, Scan Step Time[s]: 30.3662. Data acquisition was realized using X'Pert Quantify software. Data processing using X'Pert High Score software shows that the samples from Rupea include the following mineral phases: quartz, potassium feldspar, clinoptilolite, illite and carbonates. The mineral phases that compose the Govora tuffs are: quartz, potassium feldspar, illite, smectite, kaolinite and carbonates.

Regarding the mineralogical associations in both Rupea tuffs and Govora tuffs, quartz and potassium feldspars are considered to be primary phases, while all other mineral phases represent the result of the diagenetic processes that the volcanic glass has suffered. As the global chemical composition of Rupea and Govora tuffs was determined to be similar, the different subsequent evolution of the volcanic glass is due to basin conditions – salinity, pH, burial ratio.

The zeolitic transformation of the Rupea tuff shows either that the pH was higher than 9 and the salinity and alkalinity of the Transilvanian Basin were higher, or that the dynamics of the solutions was more active than that of the Dacian Basin, or a compilation of these two factors. The secondary minerals in the mineralogical association of the Govora tuff are mostly represented by clay minerals; this indicates either a lower salinity of the basin, or a proximal disposition within the basin.

# Volcanic glass transformation types and their relationship with the basin's parameters: a case study of the Rupea tuffs (Transylvanian Basin) and Govora tuffs (Carpathian Foredeep)

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## Location

<u>Volcanic tuff in Romania</u>
- Lower Badenian acidic tephra
- SE and W margin of Transylvanian basin (fig. 1)
- Intramountain basins of the Apuseni Mts.
- NW boundary - Transylvanian and Pannonian Basins
- External border of the Carpathian bend
- «Dej tuff»
- Source areas within the Carpathians (Gutai mountains)
- Probable sources in the intra-Carpathian northern Trans – Tisza area
- Rhyolitic character of volcanism (Seghedi & Szakacs, 1991)
- Age- only biostratigraphically
- Langhian (Popescu, 1970)

Fig. 1: Location of collected samples in Romania

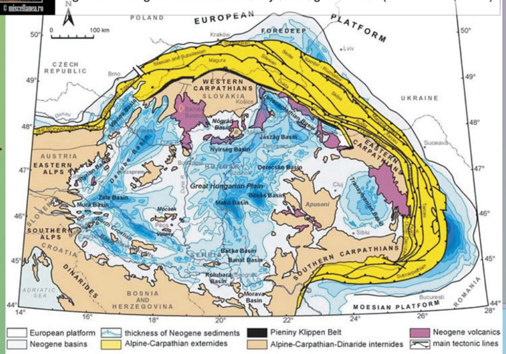

Fig. 2: An image of Central Paratethys during Badenian (Kovac et al., 2007)

## Basins' evolution

- Paratethys seas (Oriental, Central, Occidental)
- Central Paratethys (fig. 2) , uplifts in the Carpathians
- Transylvannian Basin, Carpathian foredeep - sealed off
- Evaporites, gypsum and halite
- Water communication:
  - Passage Mures
  - Possibly through northwest - Apuseni Mountains
  - Lack of salt deposits in the Pannonian Basin
  - Communication with the sea outside Carpathians
  - Olt valley and west
- Thick of tuff of Ocnele Mari region :
  - Marine transport of volcanic ash or
  - Existence of a volcanic apparatus

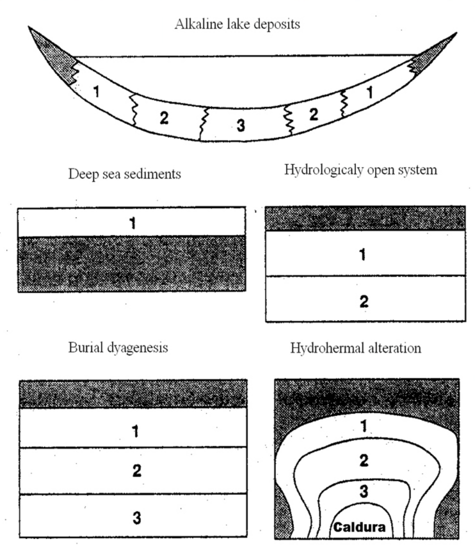

Fig. 3: Volcanic glass alteration systems

## Volcanic glass transformation types

Argillic transformation (argillization), zeolitisation
Compacting, cementing and neoformation products)

Alkaline lake system
Deep sea system
Hydrological open system
Burial diagenesys system
Hydrothermal alteration system (fig.3)

Salinity, alkalinity
pH, temperature, burial depth of the basin
Information about environmental conditions

Rupea tuff:
Vitroclasts, cristaloclasts
Intracarpathian region, rhyodacitic nature.

Govora tuff
Vitroclasts, cristaloclasts
Extracarpathian region, hydrological open system,
Rhyodacitic tuffs

Clays and zeolites
"Wet" tuffs, lacustrine or marine environments,
Smectite (moderate pH, ionic strenght)
Zeolites (higher pH and higher ionic strenght)

Hay and Sheppard (1977)
glass + Ca + Mg + H2O →clinoptilolite + Si + Na + K + Fe.

## Method, data acquisition and data processing

X-ray wavelengths are similar to inter – atomic distances
Atoms – scattering of the radiation
Regular disposition of the atoms within the crystals' lattice determines constructive interference of the diffracted radiation) (fig.4)

## Equipment:

X'Pert Pro MPD
Panalityca1 diffractometer (fig. 6)

## Data Acquisition

Samples were ground in a mortar (fig. 5)
X'Pert Quantify
Scan parameters :
Start Position [°2Th.]: 3.0167,
End Position [°2Th.] :119.9937,
Step Size [°2Th.]:0.0170,
Scan Step Time [s]: 30.3662
Measured diffractogram (fig.7)

## Data processing

X'Pert Highscore software.
Determine background
Smooth (fig. 8 , 9)
Search peaks (fig. 10)

## Results

Samples from Rupea: (Table 1)
Mineral phases: quartz, potassium feldspar, clinoptilolite, illite, carbonates (fig. 11).
Samples from Govora: (Table 2)
Mineral phases: quartz, potassium feldspar, illite, smectite, kaolinite, carbonates (fig. 12).

## Conclusions

Zeolitic transformation of the Rupea tuff - pH was higher than 9, higher salinity and alkalinity of Transilvanian Basin/ solutions' dynamics more active than of the Carpathian Foredeep/ compilation of these two factors.
Govora tuff - clay minerals, lower salinity/ proximal disposition

Depositional moment precedes a period of change regarding basin parameters (Badenian salinity crisis), we suggest further research regarding the salinity and alkalinity values at Early Badenian in both Transylvannian Basin and Carpathian Foredeep as main transformation factors.

| | |
|---|---|
| *R1* | *clinoptilolite, illiet, cristobalite, albite* |
| *R8* | *clinoptilolite, illite, cristobalite, albite, dolomite - traces* |
| *R14* | *clinoptilolite, quartz, albite, illite* |
| *R46* | *clinoptilolite, quartz, albite, illite* |
| *R54* | *clinoptilolite, quartz, illite* |
| *R61* | *clinoptilolite, quartz, albite, illite* |
| *R64* | *clinoptilolite, quartz, albite, illite* |

Table 1: Results of X-ray measurement for the Rupea tuffs

| | |
|---|---|
| *1aG* | *illite, smectite, caolinite (traces), quartz, calcite* |
| *2aG* | *smectite, calcite, albite, quartz (urme)* |
| *3aG* | *quartz, calcite, albite* |
| *4aG* | *smectite, quartz, calcite, caolinite (traces)* |
| *6aG* | *calcite, quartz, albite* |
| *7aG* | *calcite, quartz, albite* |

Table 2: Results of X-ray measurement for the Govora tuffs

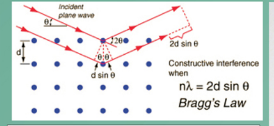

Fig. 4: An illustration of the diffraction phenomenon and Bragg's law


Fig. 5: Samples were pounded, then ground in a mortar

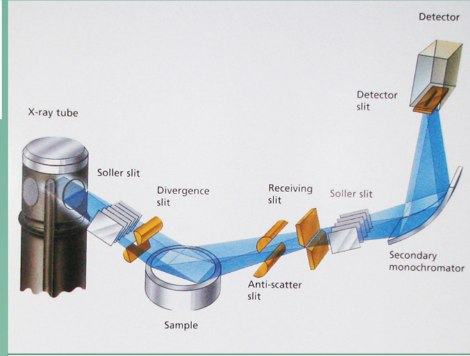

Fig. 6: Principal components of a diffractometer

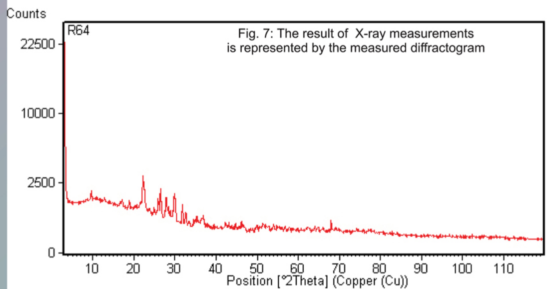

Fig. 7: The result of X-ray measurements is represented by the measured diffractogram

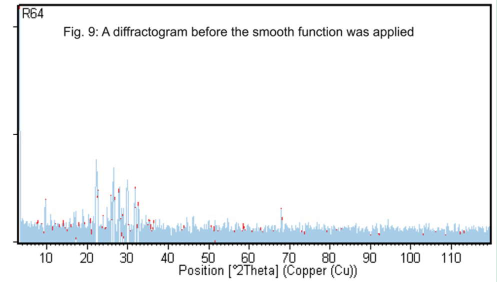

Fig. 9: A diffractogram before the smooth function was applied

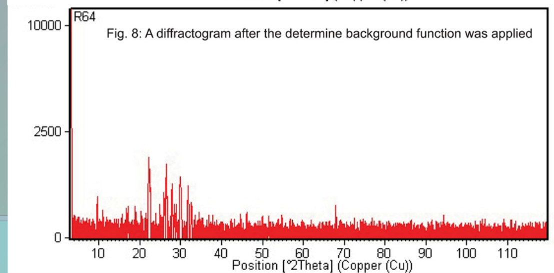

Fig. 8: A diffractogram after the determine background function was applied

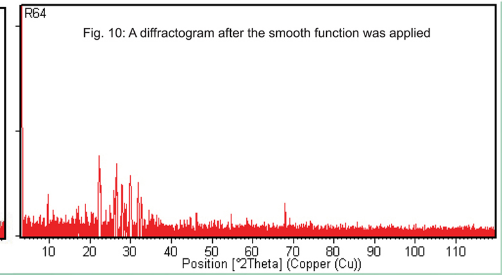

Fig. 10: A diffractogram after the smooth function was applied

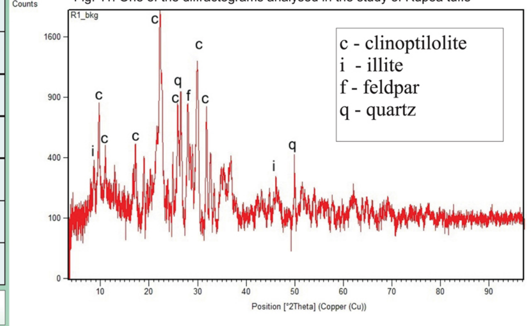

Fig. 11: One of the diffractograms analysed in the study of Rupea tuffs

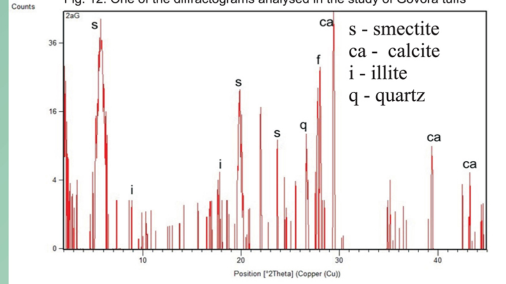

Fig. 12: One of the diffractograms analysed in the study of Govora tuffs

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