Material properties at elevated temperature

Heat Effect By Natural Stones

Dr. Mónika Hajpál

hajpal@gmail.com

Budapest University of Technology and Economics, Department of Building Energetics and Building Services
Laboratory of Building Physics
H-1111 Budapest Műegyetm rkp.3.
http://www.egt.bme.hu

Investigated stone types

Sandstones

Balatonrendes (V) – reddish, fine grain, ferruginous-clayey, Permian

Ezüsthegy (E) – white, fine grain, kaolinitic, Oligocene

Rezi (R) – greenish, medium grain, jarositic, Pannonian

Cottaer (C) – greyish, fine grain, kaolinitic-illitic, Cretaceous

Donzdorfer (Dd) – ochre, fine grain, ferrigenous clayey, Jurassic

Maulbronner (M) – reddish grey, fine grain, clayey, Triassic

Pfinztaler (Pf) – greyish red, medium grain, chlorite, Triassic

Pliezhausener (Pli) – yellowish white, medium grain, dolomitic, Triassic

Postaer (Po) – off-white, medium grain, siliceous, Cretaceous

Rohrschacher (B) – grey, fine grain, calcareous, Miocene Molasse

Limestones

Tardos compact (T) – red, pelagic, microbioclastic wackestone, Jurassic

Süttő travertine (F) – creamy, bioclastic wackestone to peloidal oncoidal packstone

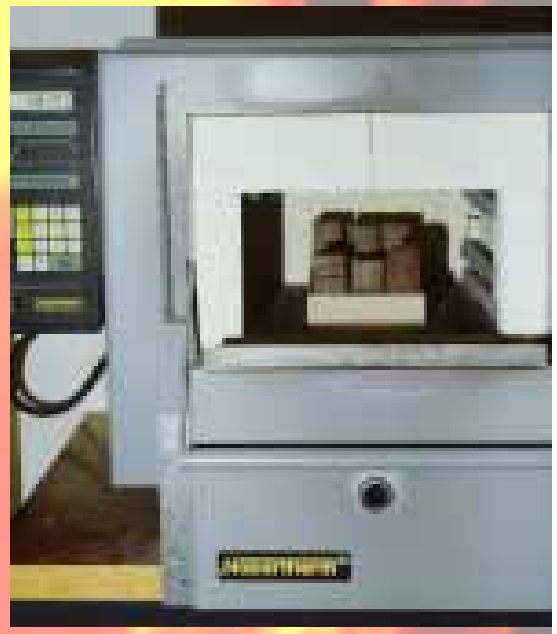
Sóskút oolitic (D) – coarse grain, Miocene

Rhyolite tuff

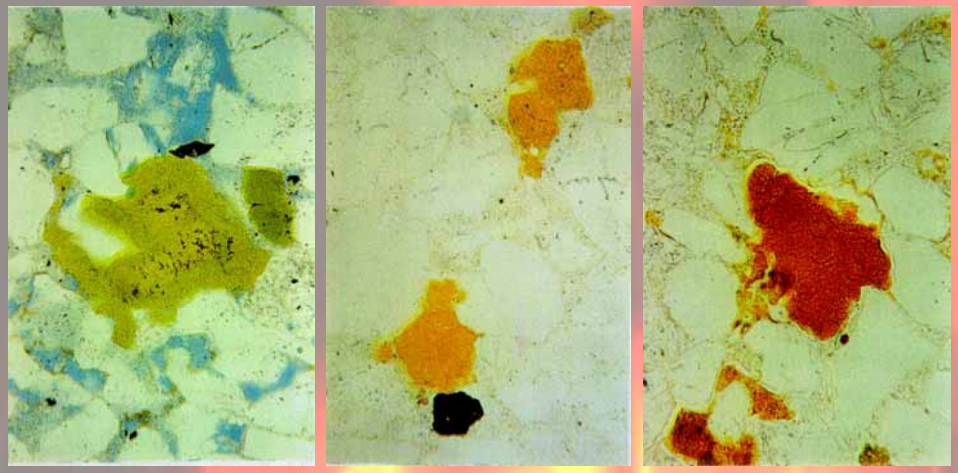
Egertihamér (Rt) – grey white, Miocene

Investigation methods

- Test conditions, heating in oven 6 hours 6 temperature (150, 300, 450, 600, 750, 900 C)
- Makroscopical investigation
- Petrological analyses
  - Thin sections analyses with Polarising microscope
    - X-ray Powder Diffraktion (XRD)
    - Differential Thermal Analyses (DTA)
    - Scanning Electron Microscope (SEM)
- Petrophysical test
  - Mass properties (specific and bulk density, porosity, water adsorption)
  - Ultrasonic sound velocity, Duroskop
  - Uniaxial compressive strength test
  - Indirect tensile strength test
  - Colour measuring (CIELAB)



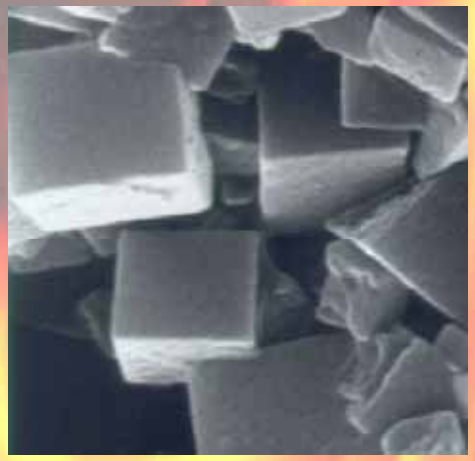
Mineralogical changes

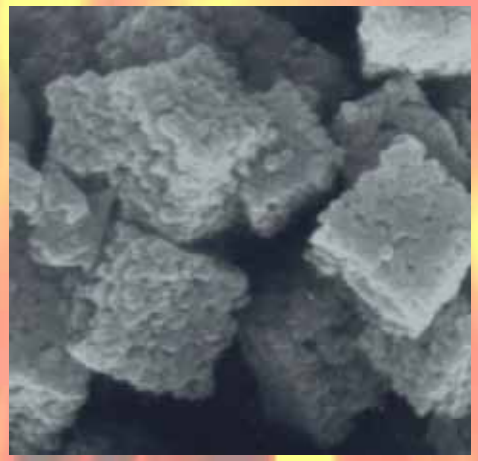


Glauconite in Cottaer sandstone (Thin section)
22°C 450°C 900°C

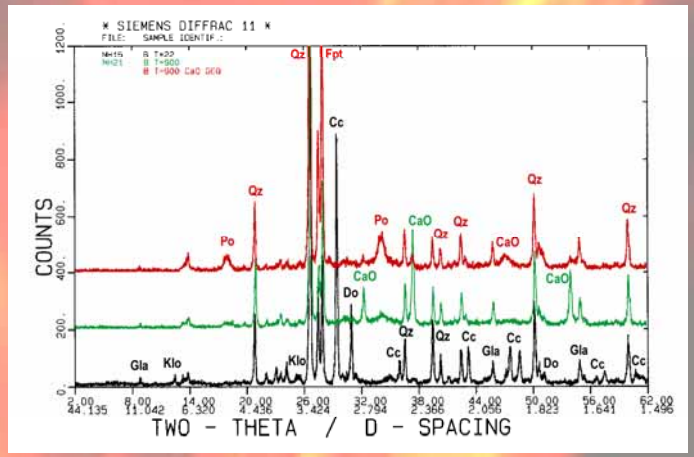
Egertihamér
rhyolite 900°C

Postaer
sandstone 450°C



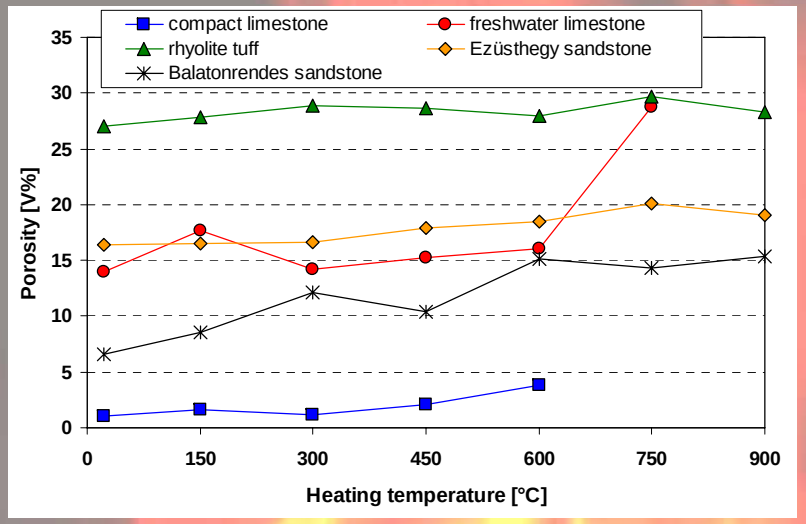


Jarosite in Rezi sandstone (SEM)
22°C 900°C

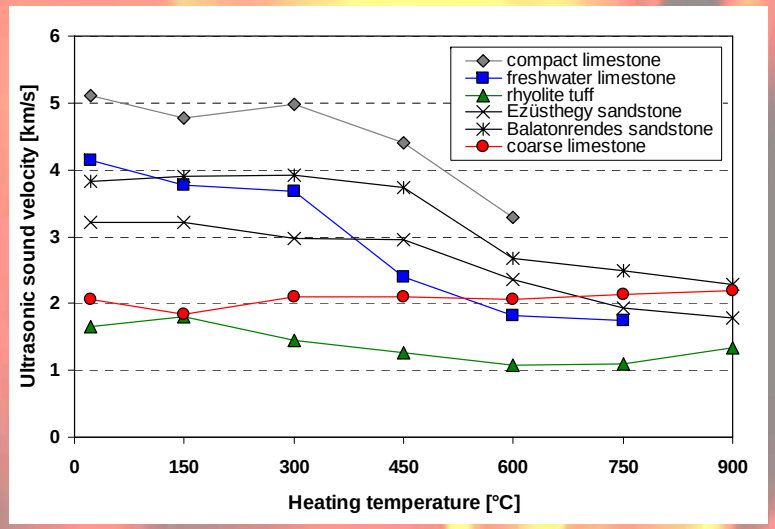


Rohrschacher sandstone (XRD)
red - 22°C **green** - 900°C **black** - later

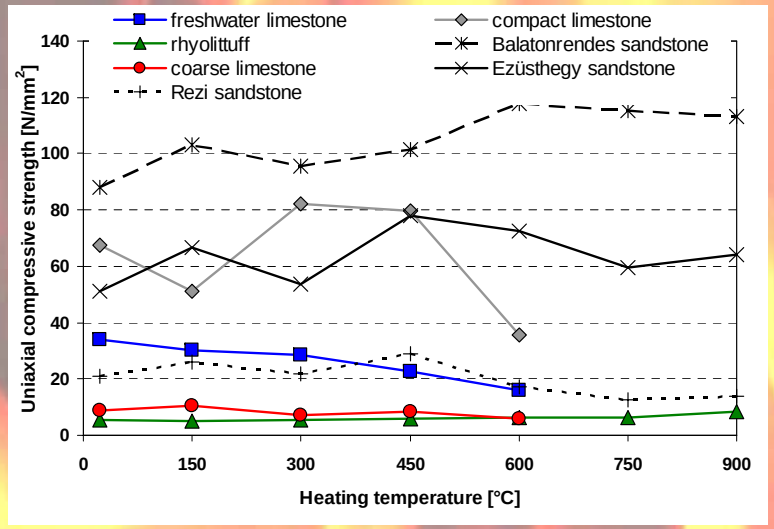
Petrophysical changes



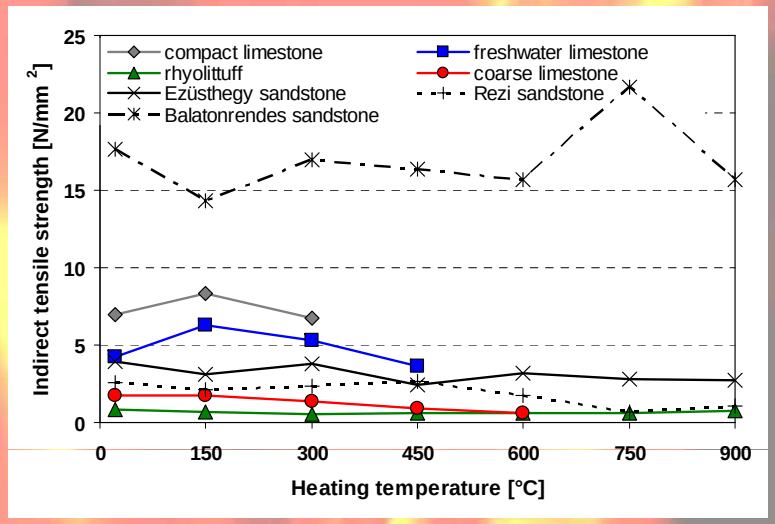
Porosity



Ultrasonic sound velocity



Uniaxial compressive strength



Indirect tensile strength

Conclusion

- At the effect of heat changes take place in the inner structure and mineral composition, which influences the petrophysical parameters
- The heat resistance depends on:
  - the type of cementing mineral
  - the amount of the cement (grain/cement ratio)
  - the grain size (fine, medium, coarse)
  - the grain to grain or matrix to grain contacts
- The compact stones show more dramatic change in porosity at elevated temperature
- The porous and cement rich stone is more adaptable, these can adopt the addition strength caused by thermal expansion
- The silica cemented, ferruginous or clayey stones are less sensitive than the carbonatic ones (disintegration at higher temperature)