Altered tephra layers in the Upper Jurassic Lemeš deposits near Maovice (Dalmatia, Croatia): Clay mineralogy and basic soil mechanic properties

Branimir Šegvić[1], Aleksandar Toševski[2], Danijela Števanić[2], Vanja Biševac[3] and Boško Lugović[1]

[1]Institute of Mineralogy, Petrology and Mineral Deposits, Faculty of Mining, Geology and Petroleum Engineering, University of Zagreb, Pierottijeva 6, HR-10.000 Zagreb, Croatia (bsegvic@rgn.hr)
[2]Department of Geotechnic, Faculty of Civil Engineering and Architecture, University of Split, Matice hrvatske 15, HR-21.000 Split, Croatia
[3]Institute of Mineralogy and Petrology, Department of Geology, Faculty of Science, University of Zagreb, Horvatovac bb, HR-10.000 Zagreb, Croatia

Upper Jurassic Lemeš deposits in the External Dinarides are the sedimentary succession comprised of light coloured platy limestones (VELIĆ et al., 1995) and/or dolomitic limestones and dolomite (BRAUN, 1991) with chert intercalations. The succession clearly deciphers different facies development than those regularly being formed within the Adriatic-Dinaric carbonate platform realm throughout the Mesozoic. It is assumed to have been moulded along the intraplatform troughs connected to the open sea.

Two bentonite layers in the vicinity of Maovice village in the Dalmatian hinterland intercalate within typical Lemeš deposits (BRAUN, 1991). The material for investigations has been sampled from the more despicably situated bentonite layers on the localities Bunarić and Gornji Ždanj. The preliminary results of our research on bentonite layers mineralogy and bentonite soil mechanic properties are briefly reported herein.

The XRD analysis of global samples reveals montmorillonite as the principal mineral in both samples accompanied by calcite, cristobalite, plagioclase (albite ?), quartz and biotite in the Bunarić sample and calcite, quartz, clinoptilolite and cristobalite in Gornji Ždanj sample. Total carbonate contents were determined to 8.06 wt.% and 26.49 wt%, respectively. Montmorillonite is defined by treatment in oriented samples from diffraction maximums showing $d_{(001)}$ = 14.8389 Å, $d_{(001)}$ = 15.0224 Å (air dried), $d_{(001)}$ = 16.6850 Å, $d_{(001)}$ = 16.6228 Å (etilenglycole saturated), $d_{(001)}$ = 9.7879 Å, $d_{(001)}$ = 9.5857 Å (heated) for Bunarić and Gornji Ždanj samples, respectively. Alteration of tephra to the assemblage of exclusively montmorillonite and zeolite from the heulandite family ($Ca_{0.54}Na_{0.08}K_{0.09}Ba_{0.03}[Al_{1.63}Si_{7.46}O_{18}]*6H_2O$ after microprobe measurement) suggests diagenesis at around pH~8, typical for the relatively deep marine setting inboard the carbonate platform.

In the grain size fraction 63-125 μm, the sample from Bunarić contains comparatively high amount of volcanic crystalloclasts. The most abundant are euheadral biotite (Mg# = 55.8-61.3; TiO_2 = 4.2-4.7 wt.%, BaO = 0.18-0.58 wt.%) and sanidine ($Or_{65.9\text{-}74.9}Ab_{24.4\text{-}33.5}An_{0.65\text{-}1.34}$) whilst quartz, subcalcic augite ($Wo_{36.5}En_{41.1\text{-}41.5}Fs_{22.0\text{-}22.3}$), hyperstene ($Wo_{1.6}En_{59.2}Fs_{39.2}$) and potassium tschermakite are occasionally observed. Radiolarian fossils are abundant in both samples. Volcanoclastic mineral composition and mineral chemistry of the Lemeš deposit tephra layers strongly suggest a high-K calc-alkaline (rhyolitic?) volcanic arc as the source of tephra. Apparently similar composition of the volcanic crystalloclasts might be an indicator of tephra input related to the eruption(s) from a single regional source.

According to the grain size composition and content of calcite Bunarić sample is classified as clayey silt (clay 30%, silt 66%, sand 1%, gravel 3%) and Gornji Ždanj sample as calcareous silty clay (clay 52%, silt 40%, sand 6%, gravel 2%); classification scheme after KONTA (1969).

Soil mechanic properties are being reported for Bunarić and Gornji Ždanj respectively. Measured dry densities are set to 2.59 Mg/m^3 and 2.64 Mg/m^3, while weight densities are 25.43 kN/m^3 and 25.91 kN/m^3. Plastic limits of tested material are 45.54 % and 36.65 %, with liquid limits set to 86.85 % and 104.82 %. Increases of soil volume after the free swell test are up to 87% and 92 %. The oedometer consolidation test showed modulus of compression for stress increment from 100 kPa to 200 kPa nearly 3.8 MPa and nearly 2.5 MPa. Overall soil mechanic tests data clearly imply high compressibility, high swell aptitude and wide range of plastic state of analyzed bentonites.

References:

BRAUN, K. (1991): Mineraloško-petrografske karakteristike i geneza ležišta bentonitskih glina Maovica, Gornje Jelenske, Bednje i Poljanske Luke.- Acta Geol., 21, 1-34.

KONTA, J. (1969): Quantitative analytical petrological classification of sedimentary rocks.- Acta Univ. Carol., Geologica 1, 175-253.

VELIĆ, I., TIŠLJAR, J. & VLAHOVIĆ, I. (1995): Jesu li vapnenci s rožnjacima u gornjoj juri Gorskog kotara "Lemeš naslage"?.- In: VLAHOVIĆ, I. & VELIĆ, I. (eds.): lst Croatian Geological Congress, Abstract Book, Zagreb, p. 96.