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Scientific Paper - Note

The Sedimentological Significance and Stratigraphic Position of Coarse-Grained Red Beds (?Oligocene) of the Northwestern Margin of Mt. Požeška Gora (North Croatia)

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Keywords: Coarse-grained clastics, Continental sediments, Red beds, Oligocene, Mt. Požeška Gora, Croatia

Ključne riječi: krupnozrnasti klastiti, kontinentalni sedimenti, crveni slojevi, oligocen, Požeška Gora, Hrvatska

Abstract

Coarse-grained clastic sediments of rhyolitic-granitic composition which are associated with the magmatic complex of Mt. Požeška Gora were previously designated as granites. They are deposited in a continental environment or, more precisely, in an alluvial fan or proximal parts of a braided river system, or in rapid mountain streams during a strong rainfalls. According to their spatial relationship with respect to surrounding Upper Cretaceous granites and rhyolites and Ottnangian sediments; and considering the facies characteristics, we assume that these sediments belong to the Oligocene.

Sažetak

Krupnozrnaste klastične stijene, koje su vezane uz magmatsku masu Požeške Gore, bile su prije izdvajane kao graniti. Sedimentološkom analizom uzoraka utvrđeno je da se radi o krupnoklastičnim sedimentima riolitno-granitnog sastava. Taloženi su vjerojatno u kontinentalnim uvjetima, i to u okolišu aluvijalne lepeze ili proksimalnim dijelovima sustava prepletene rijeke, odnosno u bujičnjacima za jakih kiša. Na temelju njihovog prostornog odnosa i superpozicijskog položaja prema okolnim gornjokrednim granitima i riolitima, te sedimentima otnanga, kao i facijesnih obilježja, pretpostavlja se da su opisani sedimenti oligocenske starosti

1. INTRODUCTION

Coarse-grained clastic sediments of rhyolitic-granitic composition occur in the northwestern part of Mt. Požeška Gora, frequently associated with granites. Due to the high degree of weathering, it is difficult to distinguish them from granites. This is very probably one reason why they were not registered by the previous investigators who examined magmatic rocks of this area.

Magmatic rocks of Mt. Požeška Gora, along with the coarse-grained clastic sediments linked to them, have been investigated since the middle of last century. So, STUR (1861, 1862) described "felsic porphyrites" and "porphyritic tuffs" in Mt. Požeška Gora. Following the works of KOCH (1917, 1919), TUĆAN (1919) and LASKAREV (1931), BARIĆ & TAJDER (1942) were first who distinguished, in the investigated area, granitic group, acid volcanic group and basic volcanic group, respectively. Volcanic rocks were decribed, in more details, by TAJDER (1944, 1947, 1955, 1956, 1959). Lately, ŠPARICA et al. (1979, 1980), MAJER & TAJDER (1982), PAMIĆ, (1988), PAMIĆ et al. (1990), PAMIĆ & LANPHERE (1991) were able to distinguish various types with regard to texture and structure. Based on examined geological relationships between volcanic and sedimentary rocks, PAMIĆ & ŠPARICA (1983) and ŠPARICA & PAMIĆ (1986) concluded that volcanic rocks belong to the Upper Cretaceous, which was proved by radioisotope dating of both extrusive and intrusive acidic rocks only (PAMIĆ et al., 1990).

During the geological mapping of Mt. Požeška Gora for the Geological Map of the Republic of Croatia (1:50.000), the above mentioned rocks were singled out and the mode of their occurrence and their possible stratigraphic position were established. The geological implications of this distinction are noteworthy.

2. GEOLOGICAL POSITION

Mt. Požeška Gora is situated about 150 km ESE of Zagreb (Fig. 1) and occupies the middle part of southern chain of mountains which encompass the Požega valley. Magmatic rocks, coupled with coarse-grained clastic rocks of rhyolitic-granitic composition, are spread throughout the northeastern part of Mt. Požeška Gora.

Volcanic rocks are spread from the Bukovica Creek, to the west, to the town of Pleternica, to the east.

The majority of the complex consists of alkali feldspar rhyolites (PAMIĆ et al., 1990), the major wide-spreading being in the eastern part, where they formed a disintegrated rhyolitic body. Much smaller occurences of alkali feldspar rhyolites are found in the western part of the volcanic complexes, where they

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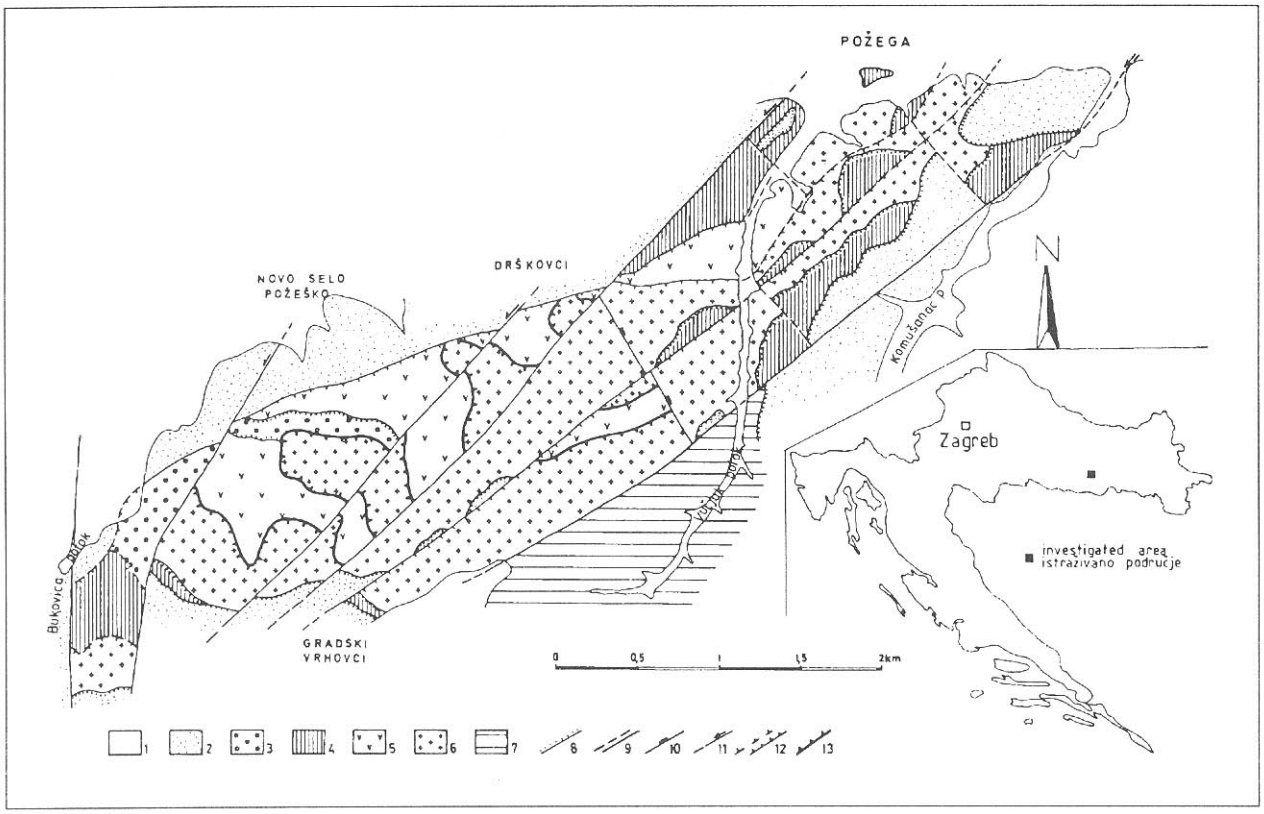

Fig. 1 Schematized geological map of investigated area (after HALAMIĆ, 1992)
L e g e n d: 1. Quaternary, 2. Neogene, 3. Tertiary, generally, 4. Coarse-grained red beds, 5. Volcanic rocks, 6. Granite, 7. Upper Cretaceous sediments, 8. Unconformable contact line, 9. Fault without character of movement, 10. Normal fault, 11. Strike-slip fault, 12. Reverse fault, 13. Gravity nappe.

Sl. 1 Shematska geološka karta istraživanog područja (prema HALAMIĆ, 1992)
L e g e n d a: 1. Kvartar, 2. Neogen, 3. Tercijar, općenito, 4. Krupnoklastični crveni slojevi, 5. Vulkaniti, 6. Graniti, 7. Sedimenti gornje krede, 8. Diskordantna granica, 9. Rasjed bez oznake karaktera, 10. Gravitacijski rasjed, 11. Transkurentni rasjed, 12. Reverzni rasjed, 13. Gravitacijska navlaka.

show up as a gravity nappe over basic rocks or, as a tectonic window below the granitic gravity nappe unit (HALAMIĆ, 1992).

Acidic intrusive rocks were observed almost exclusively in the area between Novo Selo Požeško, Gradski Vrhovci and Požega, where they extend over 4.5 km^2. According to STRECKEISEN (1973), these rocks are included in the group of alkali feldspar granites, more precisely alaskites (PAMIĆ, 1988). Different types of rocks which build up this group are: alkali feldspar granite, granophyric alkali feldspar granite and alkali feldspar granite porphyry. These rocks are separated from the Tertiary sediments in the west by the north-south striking fault following the valley of the Bukovica Creek. Toward the east, granites are in the tectonic contact with Upper Cretaceous and Ottnangian sediments marked by a left strike-slip fault of northeast-southwest direction (Fig. 1).

The extent of basic rocks is greatest in the middle part of the magmatic complex, where they show up in the form of lavas, while smaller occurrences can also be found in the western part. However, Upper Cretaceous sediments, alkali feldspar rhyolites and granites are cut across by numerous diabase veins (HALAMIĆ et al., 1990; HALAMIĆ, 1992).

Coarse-grained clastic rocks of rhyolitic-granitic composition were observed only in the western part of the previously described magmatic complex of Mt. Požeška Gora, where they are exclusively associated with granites, being in unconformable contact with them. The greatest extent of these sediments were found in both sides of the Vučjak Creek south of Požega, together with small occurrences directly north and west of the village of Gradski Vrhovci. The investigated sediments occupied a surface of about 1.5 km^2 (Fig. 1).

Between Drškovci and Požega, effusive rocks are pushed in reverse position over the coarse-grained clastics which are in tectonic contact with Ottnangian sediments in this place along a strike-slip fault. The relationship between coarse-grained clastics and other Tertiary sediments is unknown, due to the cover of Quaternary deposits.

Between the Vučjak and Komušanac Creeks, south of Požega, Ottnangian conglomerates and sandstones lie unconformably over rhyolitic-granitic coarse-grained clastic sediments.

It is interesting to mention that the rock outcrops in the yard of a grammar-school in Požega are built of rhyolitic-granitic coarse-grained clastic rocks (Fig. 2), instead of alkalic granites.

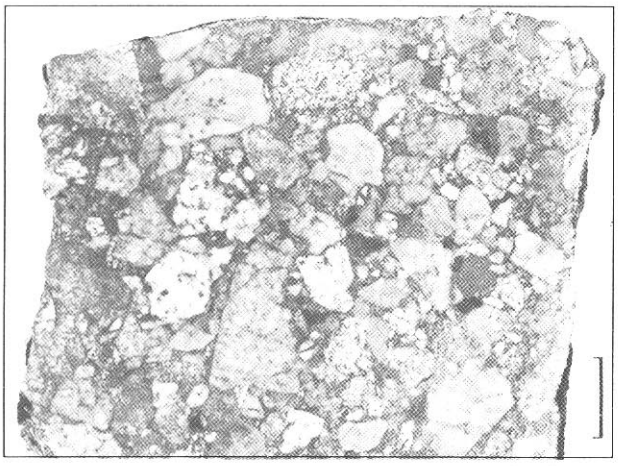

Fig. 2 Clast-supported breccia, medium to well sorted. A matrix is reddish coarse-grained sandstone. (Scalebar=1 cm)

Sl. 2 Klastpotporna breča, srednje do dobro sortirana. Vezivo je crvenkasti krupnozrnasti pješčenjak. (Grafičko mjerilo=1 cm)

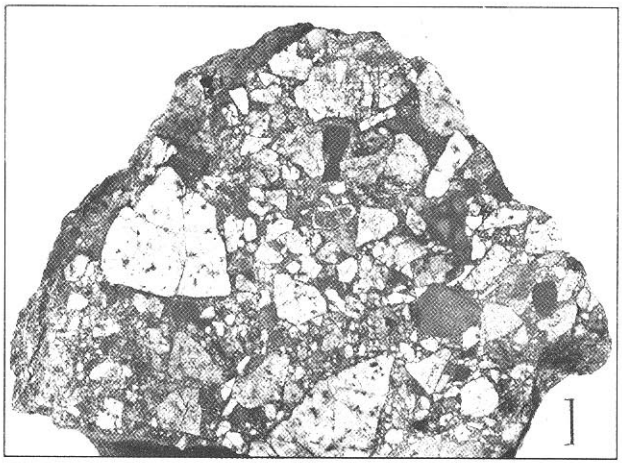

Fig. 3 Clast-supported breccia, medium sorted, with reddish sandstone as a cement. (Scalebar=1 cm)

Sl. 3 Klastpotporna breča, srednje sortirana, s crvenkastim pješčenjakom kao vezivom. (Grafičko mjerilo=1 cm)

3. DESCRIPTION OF FACIES

Coarse-grained sediments of rhyolitic-granitic composition are usually massive, very solid and strongly tectonized rocks, well-differentiated from Neogene sediments. Due to the high degree of weathering in outcrops, it is difficult to separate them from the surrounding cataclastic alkali feldspar granites. The surface of coarse-grained clastic sediments is covered with limonite and hematite coatings, which give them a yellowish or reddish colour, masking their clastic characteristics.

The bedding was hardly recognized, and in most cases this hampered us from defining the superposition in the sediment sequences. This was the main reason why sedimentological columns were not recorded, and why several samples from the particular locations were taken instead. After cutting and polishing some, significant features were emphasized.

The coarse-grained sediments of rhyolitic-granitic composition are represented by breccias intercalated with sandstones.

The breccias are clast-supported (Figs. 2, 3, 4), or, more rarely, matrix-supported (Fig. 5) when they are poorly sorted. Only two polished samples of clast-supported breccias exhibit bed planes. The lower bed plane on the intercalation of sandstone is erosional (Fig. 5), and probably flat (Fig. 6), but the upper one is rough (Fig. 5). Fragment size in breccias ranges from 2 - 150 mm. They are mostly angular and subangular, and rarely subrounded. Examples of fitting (RICHTER & FÜCHTBAUER, 1981) are not exposed. The fragments are mostly composed of granites, seldomly rhyolites. The granitic fragments include: alkali feldspar granite, granophyric alkali feldspar granite and alkali feldspar granite porphyry. The rhyolite-type fragments include: aphyric rhyolite, porphyric rhyolite and rhyolite tuff. The clast-supported breccias have a matrix composed of well-sorted, coarse- to fine-grained sandstone which, as a consequence, give them a bimodal character (Fig. 4). The matrix colour is reddish. On the contrary, fragments in matrix-supported breccias are irregularly scattered in the matrix, which is poorly sorted (ranging

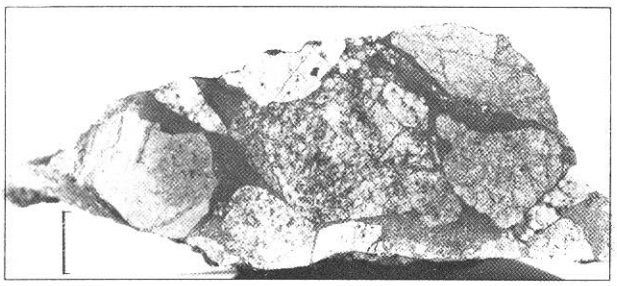

Fig.4 Clast-supported breccia, bimodal, well sorted. A matrix is fine-grained to coarse-grained sandstone, which very probably filled the space among fragments at a later stage. (Scalebar=1 cm)

Sl. 4 Klastpotporna breča, bimodalna, dobro sortirana. Vezivo je sitnozrnasti do krupnozrnasti pješčenjak, koji je vjerojatno naknadno ispunio prostor među ulomcima. (Grafičko mjerilo=1 cm)

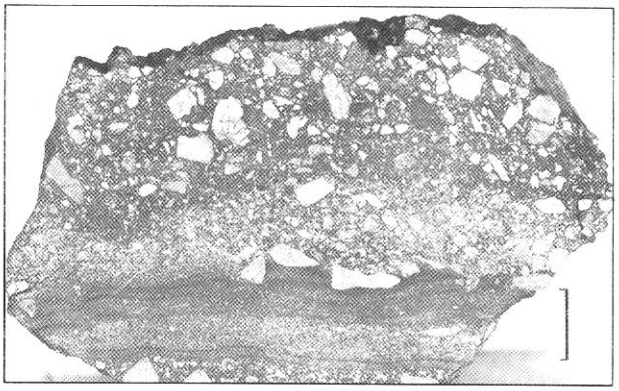

Fig 5 In the bottom part of the picture the intercalation of a sandstone within a breccia can be seen. Between the intercalation of sandstone and matrix-supported breccia there is an intercalation of clast-supported, granular breccia. (Scalebar=1 cm)

Sl. 5 U donjem dijelu slike vidi se proslojak pješčenjaka unutar breče. Između proslojka pješčenjaka i matrikspotporne breče dolazi proslojak klastpotporne, granulaste breče. (Grafičko mjerilo=1 cm)

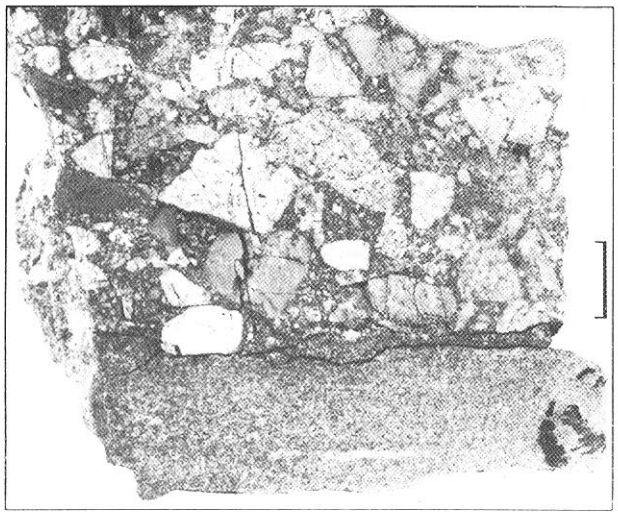

Fig. 6 At the bottom of the picture there is a part of a medium-grained sandstone intercalation. In the remain part of the picture the clast-supported breccia is shown. (Scalebar=1 cm)

Sl. 6 U donjem dijelu slike dio proslojka srednjozrnastog pješčenjaka. U ostalom dijelu slike klastpotporna breča. (Grafičko mjerilo=1 cm)

from clay to coarse-grained sandstone) and composed of grains of myrmekite, albite, microperthite, orthoclase, quartz, opaque minerals, zircon, rutile, apatite and small particles of granitic rocks, together with accumulations of sericite and chlorite. The matrix colour is reddish to brown because of Fe-minerals.

Sandstones are found at only two localities, as intercalated within breccias. They are 1.3 cm (Fig. 5) and 4 cm (Fig. 6), respectively, in thickness.

Sandstones from the first locality are laminated. Thin (1-2 mm) horizontal to slightly undulating lamination (Fig. 5) is present by a succession of poorly sorted, medium-grained lithic arenites and poorly sorted, fine-grained lithic arenites which have a greater content of a silt-clay component. The grains are mostly subangular and represented by granites, rhyolites, seldomly quartzite, feldspars (microperthite, albite, myrmekite and orthoclase) and quartz, with subordinate quantities of muskovite, opaque minerals, zirkon, rutile and apatite. The cement is a ferruginous-clay mixture, partly containing sericite, and red to light brown in colour.

Sandstones from the second locality (Fig. 6) are present by well-sorted, medium-grained lithic arenites. The sand grains are subangular and consist of granites, rhyolites, feldspars (microperthite, myrmekite, albite and orthoclase) and quartz, with subordinate quantities of muskovite, opaque minerals, zirkon, rutile and apatite. The cement is ferruginous. Fossils are not found.

4. INTERPRETATION OF FACIES

The subangularity which prevails in most particles, as well as the composition of breccias, which corresponds to the composition of bedrock acidic magmatic rocks, point towards a very short transport. Large clasts from the clast-supported breccias reveal that these sediments could have been deposited from very strong currents or debris flows. In the case of tractive transport, bimodality and grain size distribution in some samples (Fig. 4) suggest that the space between fragments could have been filled later with the fine-grained sediment from the weakened flow when the sand was deposited, still in the upper flow regime (REINECK & SINGH, 1973). In the case of debris flow, these sediments could represent washed debris flow too.

Matrix-supported breccias could be deposited from sediment gravity flows and probably represent debris flows, which have fragments supported by buoyancy and cohesion with the water-clayey matrix (MIDDLETON & HAMPTON, 1976; LOWE, 1982, 1988). This possibility is suggested by the fragment scattering in the fine-grained matrix and very poor sorting.

The rough identification of facies prevents an exact definition of the depositional environment. However, it is very likely that this coarse-grained complex was deposited in the continental environment. This interpretation is supported by the red colour of the breccia's matrix, the monotonous composition of fragments consisting mostly of bedrock, and the lack of fossils. The coarse-grained texture of the material and the variability of size and sorting suggest that these coarse-grained sediments of rhyolitic-granitic composition could have been deposited in the environment of an alluvial fan or the proximal parts of a braided river system. Matrix-supported breccias could also be deposited in rapid mountain streams during strong rainfalls. Semiarid conditions are compatible with the characteristic red colour of the matrix in alluvial fans as a consequence of the postsedimentational changes (COLLINSON, 1989).

Alternatively, the other suggestion is that at least one part of the breccias were deposited in a scree which was temporary flooded by the active streams.

5. DATING OF THE COARSE-GRAINED CLASTICS

The age of the investigated coarse-grained clastics could not be exactly determined, due to the general lack of fossils in it, although samples and thin sections were carefully examined. However, the described sediments lay unconformably over granites for which, by means of isotope dating using rubidium and strontium isotopes, an Upper Cretaceous age was established (71.5 ±2.8 Ma, PAMIĆ et al., 1990). Furthermore, the sediments belonging to the Ottnangian in age also lay unconformably over the investigated coarse-grained sediments. Additionally, all the analyzed samples have fragments composed of rhyolite and granite rocks having the characteristics of the rock types which can be found in Mt. Požeška Gora. Rhyolite and granite from Mt. Požeška Gora originate from the same magmatic chamber and are of the same age (PAMIĆ et al., 1988). Taking into account that granites are hypabyssal intru-

sives, time had to pass for them to be exhumed along with rhyolites, giving off rhyolitic-granitic coarse-grained clastics as their weathering product. Strong tectonic movements of both local and regional character should be proposed for the granite uplift. These movements can be recognized as tectonic movements in the Laramian tectonic phase of the Alpine orogeny at the Cretaceous/Tertiary boundary. The inferred semiarid conditions, prevailing during deposition, should fit the first reported arid period, i.e. the Upper Eocene up to the Middle Oligocene (ANIĆ, 1959). That is why we supposed that the coarse-grained clastic sediments of rhyolitic-granitic compositions reflect the Pyrenean phase of the Alpine orogeny and are Lower to Middle Oligocene in age.

6. CONCLUSIONS

1. The results of a sedimentological analysis on reddish colored coarse-grained clastic sediments of rhyolitic-granitic composition reveal that they can be easily distinguished from the macroscopically alike granites in the vicinity.

2. A predominant subangularity of fragments, as well as a petrographic composition corresponding to the bedrock and its proximity, point out a short transport. Moreover, the bimodality and size distribution of clast-supported breccias suggest that this material was deposited from strong currents of variable velocity, or represent debris flows. Matrix-supported breccias were deposited from debris flows. The red colour of the matrix, the coarse-grained texture of materials, the debris appearance and the lack of fossils all suggest that these sediments were very probably deposited in a continental environment, more likely in alluvial fans or proximal parts of a braided river system, or, partly, in rapid mountain streams during strong rainfalls. The possibility of sedimentation from a temporarily flooded scree is not excluded.

3. Following the conclusion that rhyolitic-granitic breccias are continental sediments deposited under semiarid climatic conditions, and that these conditions in this area after the Cretaceous were reported in the time span from Lower Eocene to the Middle Oligocene (ANIĆ, 1959), we suggest that these sediments reflect the Pyrenean phase of the Alpine orogeny, and that they are Lower to Middle Oligocene in age.

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Sedimentološke značajke i stratigrafska pripadnost krupnoklastičnih crvenih slojeva (?oligocen) sjeveroistočnog ruba Požeške Gore (sjeverna Hrvatska)

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Krupnoklastične sedimente pretežito izgrađene od ulomaka riolitno-granitnog sastava nalazimo na sjeveroistočnom dijelu Požeške Gore, gdje se najčešće pojavljuju uz granitne stijene od kojih se na terenu, zbog rastrošenosti, teško razlikuju. To je vjerojatno i bio razlog da ih dosadašnji istraživači, koji su proučavali magmatske stijene ovoga područja, nisu registrirali. U bogatoj faktografiji o magmatskim i sedimentnim stijenama Požeške Gore nema podataka o pojavljivanju riolitno-granitnih krupnoklastičnih naslaga. Stoga je zanimljivo istaknuti da su stijenski odsjeci u dvorištu Požeške gimnazije izgrađeni od riolitno-granitnih krupnoklastičnih sedimenata, a ne od alkalnih granita, kako se to ranije smatralo.

Takvi krupnozrnasti klastiti registrirani su u zapadnom dijelu magmatske mase Požeške Gore, gdje diskordantno leže na granitima gornjokredne starosti, a na njima diskordantno slijede taložine otnanga (sl. 1).

Istraživani klastiti riolitno-granitnog sastava zastupljeni su brečama u kojima se vrlo rijetko javljaju proslojci pješčenjaka. Breče su klastpotporne (sl. 2, 3 i 4), a rijetko i matrikspotporne (sl. 5). Fragmenti breča su veličine od 2 do 150 mm. Uglavnom su uglasti i poluuglasti, a manje poluzaobljeni. Većina ulomaka potječe od granita i podređeno riolita iz podloge. Matriks je kod klastpotpornih breča zastupljen dobro sortiranim krupnozrnastim do sitnozrnastim pješčenjakom. Kod matrikspotpornih breča fragmenti su nepravilno razasuti u matriksu, koji je vrlo slabo sortiran i sadrži čestice veličine od gline do krupnozrnastog pješčenjaka. Pješčenjaci su nađeni samo u dva uzorka. Zastupljeni su laminiranim do masivnim, srednjo- do sitnozrnastim, slabo sortiranim litičnim arenitima. U analiziranim sedimentima fosili nisu nađeni.

Prevladavajuća nezaobljenost ulomaka, kao i petrografski sastav koji odgovara magmatskim stijenama podine, kao i njezina blizina, ukazuju na vrlo kratak transport. Kod klastpotpornih breča bimodalnost i raspored veličine fragmenata ukazuju da je materijal taložen iz jakih struja promjenljive brzine ili da se radi o debritima, koji su mogli biti naknadno prerađeni. Matrikspotporne breče taložene su iz gravitacijskih detritnih tokova. Crvena boja matriksa, krupnozrnatost materijala, promjena jačine struja, pojava debrita i izostanak fosila ukazuju da su opisani sedimenti najvjerojatnije taloženi u kopnenim uvjetima, i to u okolišu aluvijalne lepeze ili u proksimalnim dijelovima sustava prepletene rijeke, odnosno u bujičnjacima za jakih kiša. Pri tome se ne isključuje mogućnost sedimentacije i u siparištima, povremeno preplavljivanim vodenim tokovima.

Opisane krupnoklastične naslage diskordantno naliježu na granite, kojima je determinirana izotopna starost od 71,5 ± 2,8 Ma (PAMIĆ et al., 1990), a diskordantno su prekrivene sedimentima otnanga. Starost riolita Požeške Gore, koji izgrađuju fragmente opisanih breča odgovara onoj kod granita. Za trošenje stijena različitog hipsometrijskog nivoa, a iste starosti, potrebita su jača tektonska kretanja, koja u ovom slučaju mogu odgovarati pokretima laramijske, odnosno pirenejske faze alpinske orogeneze. Kako su riolitno-granitne breče kontinentalni sedimenti, taloženi vjerojatno, u semiaridnim klimatskim uvjetima, a takvi su uvjeti na ovim prostorima u postkrednom razdoblju vladali od gornjeg eocena do srednjeg oligocena (ANIĆ, 1959), logična je pretpostavka da su oni odraz pirenejske faze alpinske orogeneze, tj. da su donjo do srednjooligocenske starosti.

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