Boris Berce

THE PROBLEM ON STRUCTURE AND ORIGIN OF THE Hg ORE-DEPOSIT IDRIJA

The data by D. di Colbertaldo and S. Slavik in « Il giacimento cinabrifero di Idria in Jugoslavia » are very interesting but they do not quite coincide with the geological statements of many investigators on this region, especially after 1945, therefore I should like to complete the features of the ore-deposit representing, according to the complication of geologic relations, nearly a unique example in the world. In the ore-deposit there appear Paleozoic and Triassic strata, of which nearly all are more or less mineralized. Consequently we get of course in the ore-deposit a lot of data being characteristical not only for Idrija, but also for the metallogeny of the Eastern Alps. In the last ten years the investigations in Črna gora, Bosna, Hercegovina, and Slovenija have pointed out that in this part of the region there is the matter about the unique Triassic metallogenesis distinguishing by a series of characteristics. It would be too wide if at discussing Idrija we encroach upon so widely. I have to emphasize that very similar data on this metallogenesis are collected completely independently from one another, and that the changes of experiences have begun « post festum » only, when we found out that it matters the equal problems and the equal type of mineralization. Consequently we cannot include the ore-deposit Idrija into the up-to-present metallogenetic schemes, as the data of the origin of the ore-deposit are such ones that they do not admit any doubt on the time of origin.

In the past century it was first thought that the ore-deposit is of the same age as the rocks (Meier, 1868). Stur (1872) connected the ore-deposit with the eruptions of «trachite». Schrauf supposed that the ore-deposit is hydatothermic and probably connected with tuffs (1891). Later on, Kossmat (1911) supposed that the ore-deposit is genetically connected to Triassic igneous rocks, merely that the hydrothermal action has begun in the Tertiar only. Kropač (1912), Piltz (1915),

NIKITIN (1934), considered the ore-deposit to be Post-Triassic. On basis of the Tornquist's data SCHNEIDERHÖHN ranged the ore-deposit into an intrusive hypoabyssic one, which in his opinion has arisen in the early Myozen (1941). At first it was supposed that the ore-deposit was of a Triassic age, until Kossmat has given a compromised solution. Later on, it was generally supposed that the ore-deposit was of Tertiarian age. Some years after the Second war when the ore-deposit belonged to Yugoslavia, it has been still researched according to the Tertiarian genetic conception.

The ore-deposit Idrija had not any geologic particulars, therefore a surface geologic map of wider surroundings has been made in 1947 - 1949 by I. GANTAR, M. HAMRLA, A. JAGER, P. SCHNEIDER. In 1951 - 1954 the author was researching only the ore-deposit. The results were given in an article, published in 1958. In 1957 I. MLAKAR doubted in the up-to-present stratigraphic sequence on beds by completing it with new data. Therefore we were studying in 1958 - 1960 the stratigraphy and tectonics on the ore-deposit and its broad surroundings. We have got a lot of new data at that work, and they are in detail explaining the structural site of the ore-deposit. The shell *Clarai Clarai* on the XI level being found by S. SLAVIK, completes the data on the ore-deposit, because in the same year we found in the « Lower structure » also the snail *Bellerophon sp.*, alongside we found fossils also in the «upper structure» of the ore-deposit.

I am giving here only a scheme on a range of beds in fig. 1. The sedimentation cycle in the researched region is shown in fig. 1. in the author's article from 1960. Nearly all stratigraphic horizons are argued

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Fig. 1. — *Stratigrafical Range of Beds in the Surrouding of Idrija* — 1. Carboniferous shale, 2. Grödenian sandstones and conglomerates, 3. Upperpermian dolomite, 4. Upperpermian limestone, 5. Lowerscytian shales, 6. Lowerscytian sandy dolomite with mica flakes, 7. Lowerscytian shale with oölitic limestone lenses, 8. Lowerscytian oölitic limestone, 9. Upperscytian dolomite, 10. Upperscytian shale, 11. Upperscytian limestone, 12. Anisian dolomite, 13. « Skonca » shale and sandstone, 14. Wengenian conglomerate, 15. Wengenian dolomite, 16. Wengenian tuffs, 17. Wengenian igneous rocks, 18. Wengenian sandstones, 19. Wengenian /pseudosilian/ shale, 20. Wengenian /pseudogrödenian/ sandstone, 21. Wengenian limestone with layers of shales, tuffs and sandstones, 22. Cassian dolomite, 23. Cassian limestone, 24. Carnian limestones, sandy limestones and shales, 25. Carnian dolomite, 26. Carnian sandstones, tuffs and shales, 27. Carnian limestone, 28. Norieal dolomite, 29. Norieal limestone, 30. Lowercretaceous limestone, 31. Uppercretaceous limestone, 32 Eocene flysch.

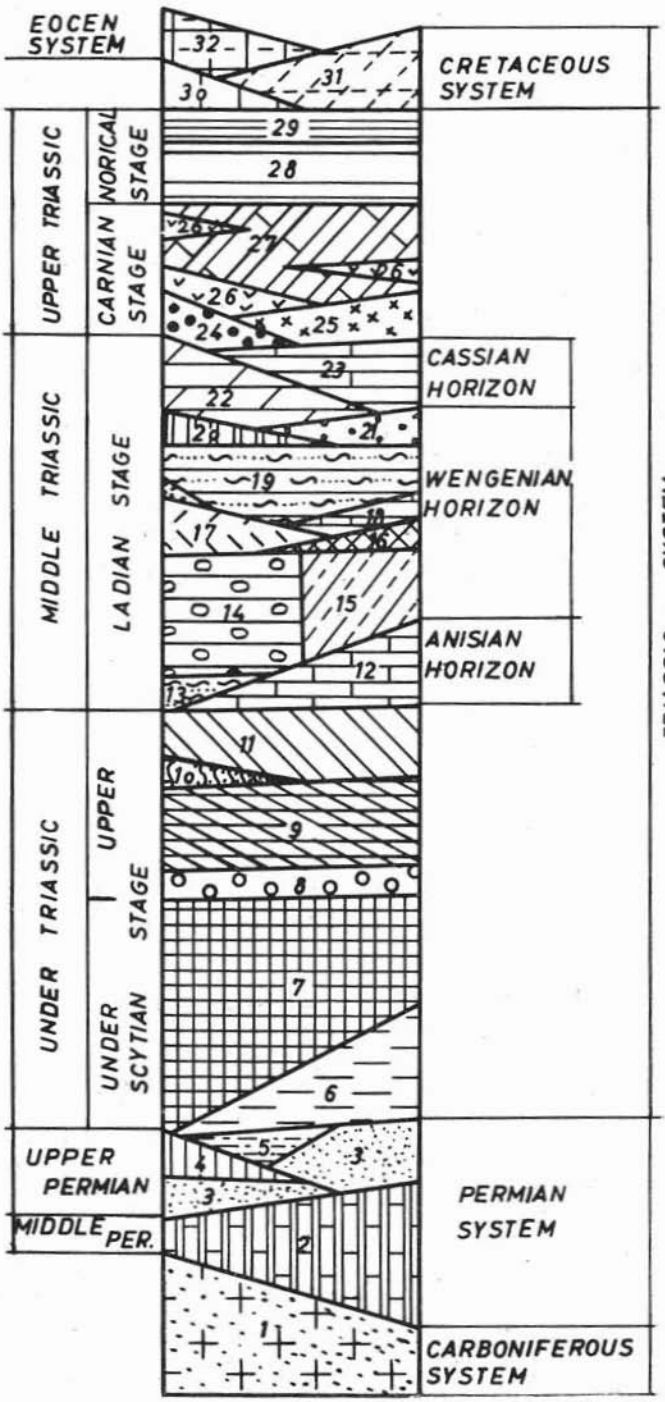
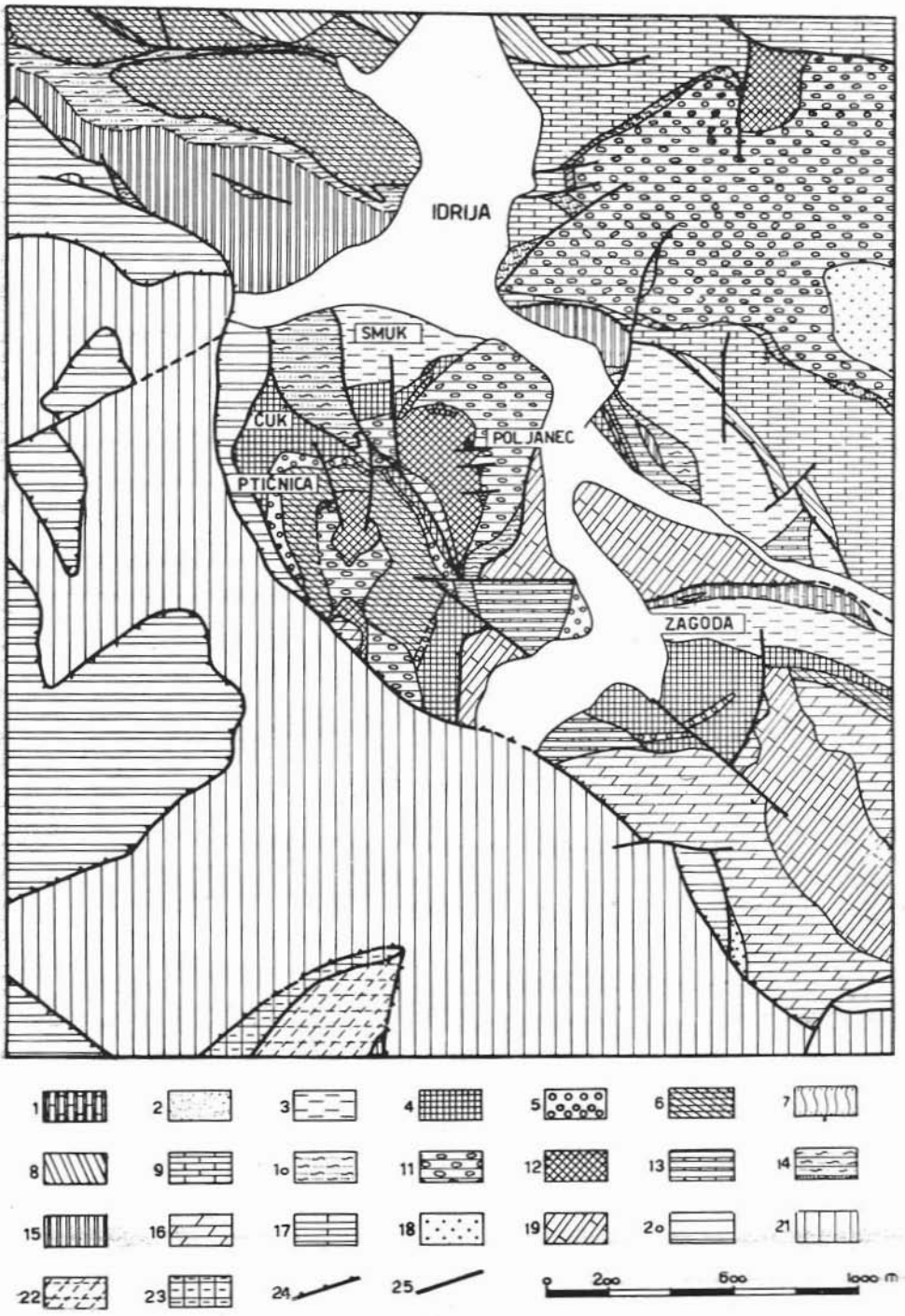

EOCEN SYSTEM
CRETACEOUS SYSTEM
UPPER TRIASSIC
NORICAL STAGE
CARNIAN STAGE
MIDDLE TRIASSIC
LADIAN STAGE
CASSIAN HORIZON
WENGENIAN HORIZON
ANISIAN HORIZON
UNDER TRIASSIC
UPPER
UNDER SCYTIAN STAGE
UPPER PERMIAN
MIDDLE PER.
PERMIAN SYSTEM
CARBONIFEROUS SYSTEM
TRIASSIC SYSTEM

Fig. 1.

in a paleontologic way with characteristical fossils. The sphere of the researched region whereon we determined the stratigraphic sequence, amounts to several hundred square kilometers. It is significant that in the same sequence the Triassic beds are developed on a highly large region through Bosna, Hercegovina, and Črna gora. Therefore I suppose that an equal development is being continued also to the west of Idrija. With regard to new, more detailistic data as given by D. DI COLBERTALDO and S. SLAVIK in the stratigraphical range, also the structure of the region is changing. For illustration I am giving a new geologic map (fig. 2) of the same part of the region, as shown in fig. 1 of the article « Il giacimento . . . ».

Under the influence of LIMANOWSKY (1910) also KROPAČ (1912) tried to explain the structure of the ore-deposit with three recumbent folds. This structure is being defended also by D. DI COLBERTALDO and S. SLAVIK. If the Idrija region were built by folds, then the strata ought to change the dip at least in one parte of the region. We have not found such changes in dips on the entire region researched. Parallely with us a group of regional geologists (M. PLENIČAR, K. GRAD, S. BUSAR, V. FERJANČIČ a. o.) have been researching some hundred square kilometers to the south of Idrija (Trnovski gozd), and they have neither there found any elements, which would admit an explanation on the structure of that region with folds. We have been investigating the ore-deposit-surroundings as well as the ore-deposit itself of which the circuit amounts to more than 10 kilometers, also by boring. We have nowhere in the boreholes found any inverse repeating of the same stratigraphic horizons; already KOSSMAT (1913) has with arguments denied any statements about folds in the Idrija-region. A little folding that has any influence on the fundamental structure exists in the ore-deposit and on the surface also (some ten to first hundred meters extensive folds).

Fig. 2. — *Geological Map of Idrija Surrounding* — 1. Grödenian conglomerate, 2. Upperpermian dolomite, 3. Lowerscytian dolomite, 4. Lowerscytian shales with oölitic limestone lenses, 5. Lowerscytian oölitic limestone, 6. Upperscytian dolomite, 7. Upperscytian shales, 8. Upperscytian limestone, 9. Anisian dolomite, 10. « Skonca » shale, 11. Wengenian conglomerate, 12. Wengenian tuffs, 13. Wengenian sandstone, 14. Pseudosilian shale, 15. Pseudogrödenian sanstone, 16. Cassian dolomite, 17. Cassian limestone, 18. Carnian limestones, sandy limestones and shales, 19. Carnian limestone, 20. Norical dolomite, 21. Lowercretaceous limestone, 22. Uppercretaceous limestone, 23. Eocene flysch, 24. overthrust, 25. fault.


IDRIJA
SMUK
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PTIČNICA
ZAGODA
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2
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4
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6
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10
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25
0
200
500
1000 m

Fig. 2.

According to the development and space position of the Paleozoic and Triassic beds we may conclude that the tectonic manifestations on the Idrija region took place in different eras. We may find out the oldest tectonics between the Carbon and Middle Perm. For a more detailistic tectonical interpretation of this tectonics however more exhaustive data are wanted because of shortage in fossils and development of beds.

The following tectonic manifestations are joined to the Middle and Upper Trias. At that time single parts of the researched region — among them also the later mineralized zone — have endured strong tectonic destructions. The Wengenian tectonics was more intensive than the Carnian one, as known the Wengenian strata are situated tectonically and erosionally discordantly even on the Permian beds. It is characteristical for these tectonic manifestations that they occurred merely on certain parts of the region, while on the other parts of the region the sedimentation of Wengenian strata was continuing apparently concordantly on Anysian strata (on the entire researched region the Buchensteinhorizon is wanted).

The Carnian tectonic phase in separated from the Wengenian one by a calm era, when the Cassian strata were sedimenting.

In the Alpine orogenesis the whole region, the ore-deposit included, has got the present structure. In this orogenesis whole blocks of beds are shifted, they have been destructed by the Triassic tectonics, therefore the data about it have been kept in the region so obviously that they can be separated in numerous places still nowadays. In this case we can't speak of the original orientation of the Triassic tectonics of course. The wider region of the ore-deposit is composed by four Schuppen. On the Upper Cretaceous strata with « rests » of Eocene-flysch there is overthrusted the Lower Cretaceous beds forming the first Schuppe in shape of a plate. The age of Cretaceous rocks was argued in 1960 by M. Pleničar and V. Ferjančič. On this Schuppe has been overthrusted another one composed by thin Carnian and Noric sediments. This Schuppe is stretching also under the ore-deposit, where it came in touch with drilling. The third Schuppe consists of Paleozoic and Triassic strata that in the under structure of Schuppe repeat themselves twice. This Schuppe has a relatively small circuit on the surface in comparison with the fourth Schuppe. Here is situated the ore-deposit

Idrija. The fourth Schuppe forms the main part of the today's surface and is composed by Paleozoic and Mezozoic beds. On the ore-deposit's region it is composed of Triassic strata only. Figure 3 shows the situation of the Schuppen, and contains the same region as figure 2. That it really matters the Schuppen is argued alongside by the equal dips of rocks and data of drillings also by the age of black shale, which has been up to now ranged by all rescarchers according to the investigations of LIPOLD (1857, 1874) in the Carbon. It is credible however that both the brachiopodes mentioned by LIPOLD are wrongly determined (RAMOVŠ, 1956). Between Smuk and Čuk and to the south of Poljanec we discovered in shales some plant-rest which argue that it matters the Ladinian strata. It is characteristical that such rests have been found by former researchers in the ore-deposit, and thus the shales have been ranged to « skonca » strata (LIPOLD 1874, STACHE 1872, KOSSMAT 1900, 1911). As the plant-rests were limited to sand-horizons appearing in the shale footwall, the clay-shales have been ranged according to their litologic similarity to the Carbon in spite of the fact, that between both the litologically different joints there is no crushed zone, on the contrary they pass into each other. Besides the paleontologic arguments there are to be found also progressive passages of the Wengenian Conglomerate into shales. Single grains of the Conglomerate are getting smaller and smaller, the cement is more sandy and dark so that the conglomerate passes in a zone of a thickness up to 2 m, gradually in shales (f. i. on the fourth level).

These shales extend from the surface to the tenth level in the ore-deposit. The detailed mapping in the ore-deposit has also pointed out that the Upper Paleozoic- and Under Triassic strata are continued up to the lowest level with the equal dip except in the northern part of the ore-deposit where the strata-dip is getting smaller. This is proved also by the statistical treatment (fabric diagrams) of the strata-dips along the particular levels. On the black shales there lie in the upper levels Cassian- and even Carnian sediments. Roughly speaking there consists the ore-deposit of the more or less steep Carboniferous shales, Permian sediments, and Under Triassic strata of the under-structure, on which there lie the gently inclined shales and sandstones, in some place or other with a calcareous admixture, as well as Wengenian Conglomerates, passing sometimes into the Wengenian dolomite, pseudo-Zilian

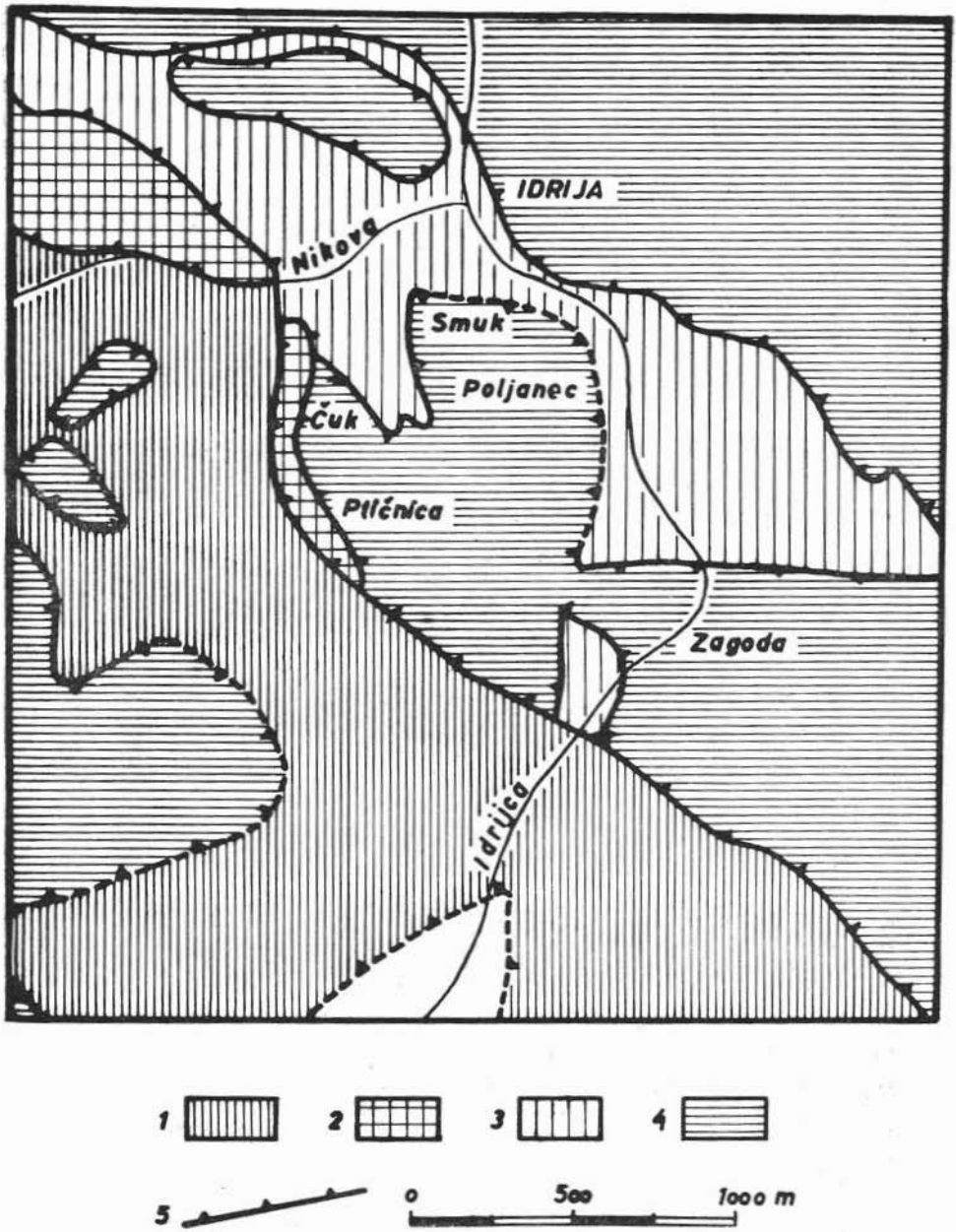

Fig. 3. — *Structure Map of the Idrija Vicinity* — 1. The first schuppe, 2. The second schuppe, 3. The third schuppe, 4. The fourth schuppe, 5. overthrust.

shale, pseudo-Grödenian sandstones, tuffs, Cassian dolomite, Carnian dolomite with sheets of Carnian tuffs forming the Upper-structure of the ore-deposit. Schematically, both structures are shown by the section (fig. 4) running through the ore-deposit. The steep strata of the lower structure are with minor deviations, connectingly continued as far as the medium dip into the depth. Nowhere in the entire ore-deposit we can in the lower structure find out the elements indicating the folds. I do

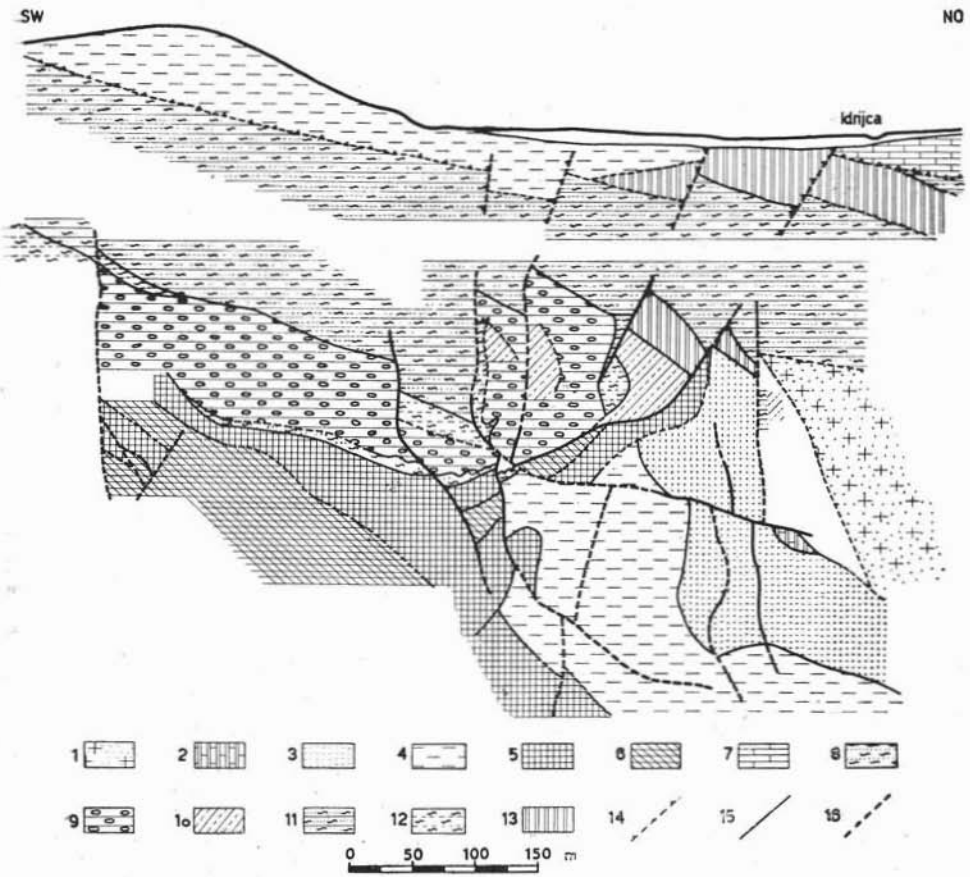

Fig. 4. — *A Schematic Section Trough the Ore-Deposit of Idrija* — 1. Carboniferous shale, 2. Grödenian sandstone and conglomerate, 3. Upperpermian dolomite, 4. Lowerscytian sandy dolomite, 5. Lowerscytian shale, 6. Upperscytian dolomite, 7. Anisian dolomite, 8. «Skonca» shale, 9. Wengenian conglomerate, 10. Wengenian dolomite, 11. Pseudosilian shale, 12. Pseudosilian sandstone, 13. Pseudogrödenian sandstone, 14. overthrust, 15. fault, 16. supposed fault.

not want to go into details too extensively for the scheme of this paper, but we can, nevertheless conclude that the overthrusts of the Schuppen structure form the vicinity as well as the ore-deposit of Idrija. It is, however, a matter of fact, that on the structurally so complicated territory we cannot get the final conclusions by the exploration of three levels in the ore-deposit forming only ten percent of the whole mine, and containing approximately 0,5 percent of the territorial area, on which the mineralization could take place.

Cinnabar occurs in the Permian, Under-Triassic, Ladinian, and even Carnian strata. The Carboniferous shale is not mineralized. The chief mineralization occurs in the contact of the under- and upper structure of the ore-deposit i. e. when on the steep, Permian, Under-triassic layers do not lie skonca shales, in Wengenian Conglomerate, in the contact with the pseudo-Zilian shale.

The latter item is most expressively indicated by the factors of the oriferousness calculated on the basis of surfaces. For the illustration I am quoting:

Level	The factors of the oriferousness of the upper structure	of the under structure	average
IV.	14	0,6	10,7
VI.	14	3,0	8,6
VII.	18	3,6	5,2

while the medium factor of the oriferousness of the « upper structure » amounts to 14,7%, is the same in the « under structure » 5,2%. The present average factor of the entire ore-deposit is 6,8%.

Of course, the cinnabar is being also laid down along the layers of the strata forming the « under-structure » as well as at the Triassic faults and fractures zones. Therefore it is understood that it does not apply to the entire ore-deposit that here is an impermeable structure in question, which has localized the mineralization. At the mineralization in the impounding structure there is essentially a filtration effect to be considered, explored closely by Koržinskij (1947, 1957, 1958) and Ovčinikov (1956). In this way the ore-bodies may occur along the impermeable strata. But when the ore-bodies are distant from these strata, the laying down of the ore has been influenced by the other factors, customary to the formation of the ore (pH, the oxydation-reduction po-

tential, Eh, the reaction between the host-rocks and the ore-solutions, changes in the equilibrium of solutions, changes P and T etc.) Therefore we cannot, of course, include all the mineralization at Idrija into the mineralization resulting from the impounding structure, according to the findings out, made by MACKAY (1946) and the later statements of other researchers. In the ore-deposit there come, consequently, into consideration, the entire interweavements of the circumstances that have caused the localization of ore-bodies, and not one type alone.

D. DI COLBERTALDO and S. SLAVIK impute to me the interpretation of the pretectonical origin of the ore-deposit. From the previous prescription on the origin of the ore-deposit structure follows clearly that there have been along the mineralized regions temporally and formally different tectonical manifestations. With the Ladinian-Carnian tectonics including also in the neighbourhood of Cerkno, Stopnik and Vojsko the flowing out of the igneous rocks and their tuffs there is connected also the origin of the ore-deposit. In the alpine orogenesis the ore-deposit has occupied its present position. The mineralized beds have been dislocated as a block in the Alpine orogenesis, and that is why the ore-deposit has been preserved to us. The western part of the ore-deposit has been swept away by erosion. In this place the surface of the beds is formed by the second and somewhere even by the third Schuppe. In the wider surroundings of Idrija there are not to be found any igneous rocks which may be of a Post-Cretaceous age.Next to the author's remaining proofs (1958) we can obtain a significant date also by the geochemical exploration of the faults arisen in the Alpine orogenesis. If there the Tertiary mineralization is to be considered, the tectonical features of the Alpine orogenesis would be either but a little mineralized, or they would contain an increased concentration of Hg. In this way we are, according to the data of OZEROVA (1960) able to follow the faults along the distances of some hundred meters. At Idrija and its wider surroundings we have nowhere found in the tectonical features of the Alpine orogenesis either the geochemical (metallometrical) anomalies or mineralization. The metallometrical researches in the vicinity of the mineralized zones yield extraordinarily significative particulars enabling the more correct investigation work. Also the single unmineralized Triassic faults display an increased concentration of Hg or even modest impregnations of cinnabar. Out of the ore-deposit we find the geochemical anomalies only in zones, in which there have

been developed the Triassic tectonics and a similar structure as at Idrija. The footwall of the ore-deposit is formed by the first and the second schuppe. Already KOSSMAT (1913) has found out that the conveying of the hydrothermal solutions through the thick Cretaceous layers is difficult to explain. Of course, doing so, we should have to discover certain fracturing zones in the lower levels of the ore-deposit, hitherto not known to us. In the vicinity of the overthrust on the second schuppe KROPAČ (1912) mentioned the fracturing ore-body on the seventh level. The works in this zone have indicated that in the Under Triassic shales there lie some variously large pieces of the put in dolomite attaining as well as the size of 0,5 m^3; the latters are strongly mineralized with cinnabar, while the shales are unmineralized at all. The pieces of dolomite have sharp edges and are fractured. This is a clear proof for an intensive fracturing in the overthrusting, and putting in a harder dolomite into shales of a higher plasticity. This date argues that the overthrust is of a younger date than the mineralization. Therefore we cannot connect the mineralization at Idrija with the occult Tertiary batholith, and the more for the reason as the ore-deposit displays a clear connection with the Triassic and not with a Tertiary structure. It would be more correct when we can from the dates of Idrija, yielded by the ore-deposit to a great extent, try to draw proofs useful for the metalogenesis of the Alps.

On the new minerals, found by D. DI COLBERTALDO, and S. SLAVIK, we cannot discuss in detail, as the data on them are too general. In any case, the pseudomorphosis of pyrite through barite are a nice piece of particulars yielding new complements on the way the ore-deposit had its origin. From the particulars on auripigment and sfalerite we cannot form any opinion on the intensivity of these minerals. Therefore, the microscopical definitions comprise either the local appearances of these minerals or there comes, owing to the lack of material, into consideration, but the approximative microscopical determination. In their mineralogical description, D. DI COLBERTALDO and S. SLAVIK do not mention the minerals, discovered by the previous researches, anymore, and for that reason, the mineralogical description of the ore-deposit as well as the paragenetical relations of minerals are incomplete. The single species of cinnabar, distinguished in the ore-deposit, according to their significant colour, have developed owing to the different intensivity of the mineralization (author, 1958), and not owing to the

influence of the barrenrocks, fracturing and similar. We find steel-coloured-ore in limestone, brecchias, and in shales. The same is the case with the remaining coloured variants of cinnabar. This demonstrates that the differently coloured species of cinnabar are not influenced by the host-rocks. The species of cinnabar occur in the tectonically undestroyed and destroyed parts of barren-rocks.

The statements of D. DI COLBERTALDO and S. SLAVIK on the fracturing and recrystallization of cinnabar show again and again that the ore-deposit has had its beginning in the Triassic, and that it has gone through the Alpine orogenesis. If the ore-deposit had started in the Alpine orogenesis, such phenomena would be limited but to the single postmineral tectonical zones and would not be spread along the entire ore-deposit. A part of the ore-bodies may be even regenerated, but for this conjecture there fail more detailed proofs. Some structural characteristics of ore-bodies show that at the investigation on the ore-deposit we have also to pay attention to possible processes of the redeposition of cinnabar.

If we are shortly to summarize the geological data on the ore-deposit, we can state:

a) The structure of the ore-deposit has had its origin in different periods of time,

b) the present structure of the ore-deposit and its wider neighbourhoods is overthrusting,

c) the mineralization occured in the Medium up to the Upper Triassic,

d) the ore-deposit has been dislocated as a block in the Alpine orogenesis to the present position.

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