

LETTERS OF THE COMMISSION ON MANGANESE (IAGOD)

REPORT ON THE TECHNICAL SESSIONS OF THE COMMISSION
ON MANGANESE, 4TH SYMPOSIUM OF THE IAGOD, VARNA-GOLDEN SANDS,
BULGARIA, SEPTEMBER 19—25, 1974

GY. GRASSELLY and I. M. VARENTSOV
President Secretary

During the 4th Symposium of the IAGOD the Commission on Manganese organized two technical sessions. At the sessions 13 scientific papers were presented. The number of participants was over 50 persons.

Technical Session I

September 23, 1974, Hotel International, Concordia Room
Chairmen: GY. GRASSELLY (Hungary), R. RASHKOV (Bulgaria)

PROF. GY. GRASSELLY, President of the Commission on Manganese opened the session. He welcomed the participants and on behalf of the Management of the Commission on Manganese he expressed his sincerest thanks to the Bulgarian Organizing Committee for the opportunity to organize these sessions. PROF. GRASSELLY outlined the main goals of the Commission on Manganese and emphasized his hope that these sessions might be a new step in the development of the Commission's activity.

1. *Ferromanganese nodules from the Gulf of Finland*; by IGOR M. VARENTSOV, Geological Institute of the Academy of Sciences of USSR, Moscow 109 017, Pyzhevskiy pereulok 7, and A. I. BLAZHCHISHIN, Atlantic Division of Institute of Oceanology of the Academy of Sciences of USSR, Kaliningrad 236 015, Prospekt Mira 1.

Of the World Ocean Basins selected for the study of formation processes of ferromanganese ores the Gulf of Finland can be considered as a typical one with an evidently distinct source of ore-forming components.

The Gulf of Finland is a peripheral part of the Baltic Sea, where the role of the continental run-off is well displayed. On the other hand, the Gulf of Finland is connected with the open sea. The main part of metals playing a role in the formation of nodules is transported in dissolved form by the River Neva and in a lesser extent by the streams from Finland.

The largest accumulations of ferromanganese nodules were observed in Eastern and Central parts of the Gulf, in areas northward of the axial troughs. The nodules are developed in the regions of considerably weak sedimentation: on the slopes of depressions, on banks and on underwater elevations.

The main morphological types of nodules are: *a*) ferromanganese hydroxide coatings on gravels and pebbles; *b*) penny-shaped nodules; *c*) discoidal nodules; *d*) crusts; *e*) beans; *f*) buckshots.

The main constituents of the nodules are the hydroxides of iron and manganese. The iron occurs mostly in form of X-ray amorphous hydroxides, less frequently in form of hydrogoethite, goethite and hematite and the manganese as birnessite with minor amounts of todorokite. In some nodules patches of manganian siderite and chlorite-like minerals can be observed.

In the Gulf of Finland from the relatively shallow areas toward the Central Trough the amount of several components of the nodules increases e. g. CO_2 : 2.00 to 3.45; Mn: 23.24 to 45.06 and on the contrary, the Fe content decreases from 60.98 to 38.78 (the values are in wt. per cent calculated on clastic-, carbonate- and silica-free basis). The content of ferromanganese compounds of lower state of oxidation is increased in this direction. These data give evidences for chemical specialization of bottom waters.

Three types of nodules can be distinguished: *a*) iron-rich (Fe: 50—76%); *b*) manganese-rich (Mn: 40—70%) and *c*) ferromanganese type of intermediate composition.

The mean composition of the nodules: SiO_2 : 17,42; TiO_2 : 0,48; Al_2O_3 : 3,14; Fe_2O_3 : 26,13; FeO: 0,38; CaO: 2,32; MgO: 1,00; MnO: 2,76; MnO_2 : 21,59; Na_2O : 2,76; K_2O : 1,71; H_2O^+ : 7,26; H_2O^- : 7,96; P_2O_5 : 2,76; CO_2 : 2,38; C_{org} : 0,97; BaO: 0,19 wt. per cent and as trace elements: Cr 17; V 68; Cu 9; Ni 35; Co 96; Zn 113 and Pb 9 (in n. $10^{-4}\%$).

The nodules are formed as a result of chemisorption with autocatalytic oxidation during interaction of active surfaces with component-bearing solutions, usually bottom waters. The chemical composition of bottom waters controls the content of the nodule's components. After formation of the hydroxide compounds during the post-sedimentary stages in nodules local processes of carbonate and chlorite-like mineral formation took place.

2. On the source of manganese accumulated in the stratified deposits and sediments of ocean floor; by PROF. V. R. NADIRADZE, Geological Institute of the Academy of Sciences of Georgian SSR, Zoi Ruchadze 1, Tbilisi, USSR.

Lately there have appeared works arguing against the sedimentary origin of the widely spread stratified manganese deposits.

The reviewed idea of a connection existing between manganese source and volcanism, inability to explain the absence of any indication of volcanism synchronic to the accumulation of manganese within or in the vicinity of the largest manganese basins on the earth (Nikopol, Chiatura, Varna, Molango (Mexico) and others) and the connection between the source of manganese and distant volcanism with the subsequent transportation of manganese bearing solutions by floor currents along tens and hundreds of kilometers assumed by this conception, is less convincing.

The ferro-manganese concretions assembled at the ocean floor are of great theoretical and practical importance. Owing to the work mainly of Soviet and American scientists the questions of their structure, composition and genesis have been well elucidated.

The critical analysis of the stored material permits some original conclusions concerning manganese sources, the conditions of its migration and concentration.

It has been ascertained that in the Pacific Ocean manganese is regularly increasing from the shores towards the central regions with pelagic sediments of different facies and that it is distributed in banded zones with the plan dis-

tinct from that of iron because of its greater geochemical mobility. This affinity enabling its vertical migration and enriching the concretions with manganese explains the high figures of the ratio Mn/Fe in the concretions.

The organic world of benthos and the floor slow currents washed the concretions and constantly kept them on the surface of the ocean floor.

By the radiological investigation there has been established the age of the concretion „Horizon” — 16 million years at the rate of growth of 0.01 mm in 1000 years.

There are two points of view concerning the origin of manganese in concretions and associated sediments. Some authors think that the main source of manganese in ocean is the underwater volcanism. Others attribute it to the continental drift. The first does not explain the absence of manganese accumulation at earlier and stronger phases of volcanism and the concentration of manganese in the Arctic Ocean which has never had any volcanism in it. The second does not explain the high content of cobalt, nickel, copper in ocean concretions, the absence of an intense manganese accumulation of the earlier periods and the mechanism of transportation of vast masses of manganese-bearing substances at immense distances. Both of them fail in explaining the global distribution of manganese and its sedimentation during the short interval of the tertiary period.

Our cosmogenic hypothesis (1970) based on the accretional theory of the origin of planets enables us to meet these questions. It assumes the mass fall of the meteor dust rich in manganese and accompanying metals upon the earth while crossing the strong meteor currents or nebulae during the rotation of our solar system around our galaxy.

The similarity of manganese concentration in the ocean sediments of different facies and stratified deposits together with the banded zonal distribution in the Pacific Ocean may turn an additional arguments for the advanced hypothesis.

3. *Manganese occurrences in the Itacaiunas River Basin, southern Amazon region, Brazil*; by WARREN L. ANDERSON, ROBERT C. DYER, Companhia Meridional de Mineracao, and DOMINGO D. TORRES, Companhia Vale de Rio Doce.

Exploration activities in the north-central Brazilian Schield have led to the discovery of three supergene-enriched manganese deposits in Precambrian meta-sedimentary and sedimentary rocks. Identified as the Buritirama, Sereno and Azul prospects, they are found in jungle-covered terrane in the remote Itacaiunas River Basin situated in the east-central of the State of Para.

The Buritirama and Sereno deposits have been formed by the weathering and supergene enrichment of manganiferous silicate-carbonate lenses within biotite schist of probable early to middle Precambrian age. These schists overlie a micaceous quartzite which forms pronounced ridges; each deposit consists of many discrete occurrences scattered along the crest of dip slopes of these ridges. The largest known lens is 1,400 meters long and up to 30 meters thick; most lenses appear to be much smaller. Protore at Buritirama ranges from calcmica schist to slightly schistose marble containing pyroxmangite, rhodonite, rhodochrosite, garnet, tremolite, epidote and similar minerals, the derived manganese oxide deposits contain cryptomelane, lithiophorite, nsutite, braunite, amorphous MnO₂, clay minerals, and in Sereno only, quartz. Sur-

face indications of individual lenses are brown soils, manganiferous pisolites and boulders and sparse outcrops of massive indurated manganese oxides. The indurated manganese oxides grade rapidly downwards to the fine-grained friable mixture of manganese oxide and clay that constitutes the bulk of the crude ore. The metasedimentary rocks at Buritirama and Sereno bear the same stratigraphic relation to the underlying basement as the rocks of the iron-bearing Grao-Para group of the nearby Carajas area and may be the distal, more highly metamorphosed equivalents of that group.

Crude ore grade at Buritirama ranges from 32 to 47% Mn. Fine screening eliminates diluent clay minerals and yields a concentrate of acceptable chemical quality. Sereno ores are lower grade and of smaller grain size, and cannot be upgraded by simple size-classification methods. Both deposits are of the same genetic type as those at Serra do Navio, Amapa and Morro da Mina, Minas Gerais; the friable nature and lower grade of the Buritirama and Sereno ores reflects the absence of massive manganese carbonate in the protore.

The Azul deposit resembles the Moanda manganese deposit in Gabon. Superficial accumulations of residual manganiferous blocks and plaquettes have been derived from the weathering and enrichment of primary manganiferous shales that belong to the Rio Fresco-Gorotire formation. This formation is an unmetamorphosed sequence of coarse to fine clastic rocks that unconformably overlies the Grao Para Group. The manganiferous shales are thought to have been deposited within a shallow lagoonal basin confined to the axial region of the synclinorium that forms the iron-bearing Serra dos Carajas district, and have themselves been affected by the complex faulting of the synclinorium. The iron formation and associated basaltic rocks of the Grao Para Group are the probable source of the manganese. The block and plaquette-bearing eluvium and down-slope accumulations of manganiferous pisolites form an east-west zone about 4.5 km in length. Manganese minerals identified are lithiophorite, cryptomelane, pyrolusite and psilomelane. Preliminary analyses show the grade of the plaquette and block detritus to range from 33 to 49,6 % Mn.

4. *Manganese ores in the weathering crust of Kazakhstan, USSR*; by B. M. MICHAILOV, V. G. KOLOKOLTSEV and YU. M. VOROBYEV, All-Union Research Geological Institute, USSR Ministry of Geology (VSEGEI), 72b Sredniy Prospect, Leningrad 199 026, USSR.

The bauxite-bearing suffosion-karst depressions localized at the contacts of manganiferous carbonate rocks and metasomatites were studied in Western Kazakhstan, northern part of Turgai Depression, iron ore quarries of Skolovsko-Sarbaevskiy group of mines. Manganese ore occurred along the flange and on the basement of karst conical depression on the manganiferous limestones and weathered metasomatites. The manganese ore accumulations are of 1—2 m thickness, volume weight 1 g/cm³ and are composed of unconsolidated hydroxides of manganese (Mn up to 63.7%) and iron (Fe up to 58,0%). These accumulations of manganese ores coming down in the form of train, they are overlapped by ferruginous bauxites, ferralites and less frequently by carbonaceous clay containing remnants of Cretaceous flora.

The marked boundary between manganese ores and bauxites, the absence of manganese in bauxites and allites testify to the fact that they had been form-

ed under very different conditions. Judging from the rock relationships manganese ores had been formed before the formation of bauxites took place.

Probably the same time-break between the formation of manganese weathering crust and the bauxite ones are observed in other regions of Kazakhstan.

In the south of Central Kazakhstan on the limbs of ancient Dzhailminskaya syncline Devonian carbonate and effusive rocks are outcropped. The Cretaceous weathering crust developed on these rocks are eroded. The weathering crusts formed on Dzhailmanskaya syncline are occurred on ferromanganese ores and on the enclosing carbonaceous-clayey-carbonate rocks which are survived in the weak board zones. Manganese deposits Karadzhal, Katy, Ushkatan and others are related to these zones. The thickness of the weathering crust in this area 70—100 m.

Manganocalcite, braunite, jacobsonite, rhodonite ores, formed in result of sedimentary processes in Famennian age and metamorphosed later in Upper Paleozoic epoch of folding, were transformed in the weathering crusts into psilomelane-vernadite oxide ores. Enclosing rocks without their carbonate constituents (but containing entirely the initial organic matter) were altered into siliceous-clay and carbonaceous-clayey-siliceous rocks with volume weight to 1,18 g/cm³. In some cases the volume weight is somewhat increased in result of distinct silica metasomatism, observed in slides. The newly formed quartz is the product of such reactions.

The fact that manganese ores contain minerals with manganese of high and intermediate degree of oxidation (Mn^{4+} ; Mn^{3+}), the presence of ferric iron only (goethite, hematite) as well as the fact that content of Cu, Zn and Pb is much higher than their clark concentration for carbonate rocks (by a factor 10^2 — 10^5) indicate that manganese ores had been formed under alkaline ($pH > 8$) and highly oxidized conditions.

Paleotectonic and paleogeographic environments on the territory of Kazakhstan from the Late Paleozoic to Paleogene time allow to suppose that manganese weathering crusts were formed during the periods of subarid peneplanation of Kazakh Highland (Late Jurassic-Lower Cretaceous) before the humid period Albian — Cenomanian.

5. *Mount Brandsnuten manganese deposit*; by DIRK VAN DER WEL, Mineralogisk-Geologisk Museum, Oslo, Norway.

Mt. Brandsnuten manganese deposit is located in the province of Telemark in the high-mountain range of central southern Norway. The Telemark area consists of supracrustal-, gneissic- and granitic to monzonitic rocks. Hydrothermal action has left veins with sulfide minerals, fluorite and others.

The manganese deposit occurs in a supracrustal sequence and consists of a thin band approximately 2 kilometres in length, lying within a quartzofeldspathic metasandstone. The band is discontinuous and seldom exceeds a few centimeters in width, but can be up to 2 metres wide. Close to the deposit is a body of porphyritic granite. Granitization is widespread in this area, which probably represents a deeper section of the Telemark supracrustal area from which it is separated by a fault. The ore body is considered to be of primary sedimentary origin. During metamorphism oxyhydroxydes were altered to manganese-oxides and -silicates (gondite). All of the present minerals in the deposit are considered to have been produced during metamorphism of later. Jacobsonite, hausmannite and braunite are early phases, whereas rhodonite and

spessartine were formed somewhat later. Retrograde processes caused part of the rhodonite to be converted to spessartine. During the hydrothermal stage fluorite, rhodochrosite, native copper and others were precipitated. This stage is probably also responsible for the variations on the ratio of $(Mn + Al) : (Ca + Fe^3)$ in the garnets in the metasandstone along the borders of the manganese band. The environmental conditions of high Mn contents along with varying Fe contents and Ca-metasomatism have given a unique possibility to study the variations within the compositional field of the grossular-andradite-spessartine molecules of the garnets. Electron-microprobe analyses reveal a compositional range from relatively pure spessartines through intermediate compositions towards the andradite molecule.

Some of the mineral phases formed during the hydrothermal stage have relatively high contents of REE and other heavy metals. In particular a manganese-epidote with a high MnO-content has locally a REE content in the order of 10 wt%.

Chairmen: I. M. VARENTSOV (USSR) and G. KANURKOV (Bulgaria)

6. *Regularities of location of manganese formations in the USSR*; by V. P. RAKHMANOV, E. M. GRIBOV, O. G. LAZUR and YU. A. KHODAK, Laboratory of Sedimentary Mineral Resources, Ministry of Geology of USSR, 17 Marii Ulyanovoy, korp., 1. Moscow V-331, USSR.

Sedimentary and volcanogenic-sedimentary Precambrian and Phanerozoic manganese formations with manganese and iron-manganese ores, that are located on the territory of the USSR, are situated on the slopes of old masses, in subplatformes, medial massifs, in edge bending flexures, miogeosynclines, eugeosynclines.

The scales of manganese ore accumulation sharply increase from Precambrian towards Kainozoic; zones of concentration of the ores are dislocated from geosyncline regions into subplatform and platform ones; in formations with the commercial accumulation of manganese ores the terrigenous sediments begin to dominate.

Paleotectonic and landscape-climatic situations greatly influenced the composition, structure and conditions of the localization of manganese formations. The map of location of manganese formations found in different regions of the Soviet Union is analysed.

The scheme of the stratigraphic distribution of manganese deposits and occurrences in the USSR with the quantitative valuation of manganese, that they contain, is adduced.

7. *Mineralogy of iron and manganese ores of Western Atasu Central Kazakhstan, USSR*; by M. M. KAYUPOVA, K. I. SARPAEV, Institute of Geological Sciences, Academy of Sciences of Kazakh SSR, Alma-Ata, USSR.

Iron and manganese ores of Atasu deposits are confined to a single silica-carbonate-zinc-manganese-iron ore hydrothermal sedimentary formation of Famennian age, developed within the Zhailmin synclinorium complicated by smaller faults and folds.

According to the author's investigation data, this formation represents a natural association of synchronous lens- and seam-like zinc, iron, manganese and iron-manganese (zinc- and germanium-bearing) ore bodies and substantially carbonate sedimentary rocks enclosing them, that under conditions of the

deposits mentioned have for the first time been divided into six ore facies: siliceous-carbonateous-manganous, siliceous-carbonateous ferruginous, aluminosilicate-carbonateous-ferruginous (germanium-bearing), aluminosilicate-carbonateous-manganous (zinc-bearing), aluminosilicate-carbonate-ferruginous-manganous (zinc- and germanium-bearing) and sulphide-ferruginous (zinc-bearing).

The peculiarity of iron and manganese ores is in the development of varied textures and structures reflecting all the features of sedimentation processes and ore substance alteration. Among ore textures and structures originated during certain stages of formation of Atasu deposits, four genetic groups can be distinguished: 1) originated in the course of sedimentation and diagenesis; 2) formed due to metamorphism; 3) originated in connection with hydrothermal metasomatic activity; and 4) formed owing to hypergenic processes.

Each genetic group of textures and structures is characteristic for particular physico-chemical and geological conditions of ore substance accumulation and its further evolution under the action of diagenetic, metamorphic, hydrothermal-metasomatic and hypergenic processes.

Iron and manganese ores of Atasu deposits are characterized by a unique set and paragenesis of rare minerals. Not only in Kazakhstan but all-over the Soviet Union are so far unknown analogues of Atasu deposits in terms of mineral composition diversity of their ores. In addition of common ore—forming iron and manganese minerals some new mineral varieties and a great number of those found for the first time in the USSR have been discovered in Atasu. The Atasu deposits are similar to those of Franklin (New Jersey, USA) and Långban and Nordmarken (Sweden) with regard to the complex of oxide carbonate, silicate with chlorine and arsenic compounds of zinc-manganese-iron, lead-manganese, boron, strontium, manganese (ferro-zinc jacobsite, zinc jacobsite, zinc hausmannite, zinc oligonite, coronadite, kentrolite, faulerite, friedelite, pyrosmalite, ferruginous friedelite, severginite, strontium piedmontite, arsenate (manganberzeliite, brandtite, sarkinite) and others.

The ore accumulation process seems to involve three stages: hydrothermal-sedimentary, hydrothermal-metasomatic and hypergenic.

8. *The manganese ore deposit of Kisenge, Kamata (Western Katanga—Shaba, Zaire). Geochemical composition of the primary carbonate ore;* by LOUIS DOYEN, Laboratoire de Geologie Appliquée, Université Libre, 50 Av. Roosevelt, 1050 Bruxelles, Belgique.

The manganese ore deposit of Kisenge — Kamata, of Precambrian age, must be considered as being of sedimentary origin. The primary carbonate ore is mainly composed of rodochrosite and subsidiarily of spessartine, rhodonite and braunite. The primary ore is metamorphised and rich in graphitized carbon.

The geochemical study of the primary carbonate ore is mainly based on an original application of quantity determination made by atomic absorption and on the results of the quantity determinations made by emission spectrography.

The carbonate ore is characterized by:

- a very weak iron content: 0.83%,
- relatively low calcium and magnesium content, 2,59% and 1,85%, respectively,
- the presence and the relatively homogeneous distribution of minor elements within the carbonate mass: Ni: 1.420 ppm; Co: 460 ppm; Zn: 597 ppm.

The study of the partial correlations has revealed the existence of very strong connections existing between

calcium and magnesium,
nickel and zinc,
cobalt and phosphorous.

Therefore, these elements are connected two by two by precipitation.

9. *Gondite occurrences in the Central Old Planina, Bulgaria*; by Kr. KOLCHEVA, Zh. IVANOV, D. DIMOV, University of Sofia, Bulgaria

In Early Paleozoic rocks of Mount Bilo, Central Old Planina were found some layers of metamorphosed manganese-bearing rocks: gondites. The layer's length: 3—4 km, thickness 1—2 to 20 m.

The gondites are the massive rocks, partly with well expressed banded structure. The fresh surfaces of these rocks are of gray, pink-gray colour, but the weathered rocks are dark brown-black brown, with the fissures filled by ferro-manganese oxides, hydroxides.

The most common minerals are spessartine (50—85%) and quartz (20—50%), rhodonite is occurred less frequently, as well as the manganese carbonates and tremolite.

In fresh, unaltered gondites the manganese content: 15,82—21,86%, but in the weathered rocks: 23,90—38,23% Mn. The phase analysis gives the evidences that manganese are presented mainly in silicate form, and the minor part of this element is in the form of manganese carbonates: manganocalcite, rhodochrosite. In the rocks altered by supergene processes the amount of oxide form of manganese is increased.

The content of Co, As, Mo, Zn, and P is higher than the average clark concentrations of these elements.

All Early Paleozoic rocks of Old Planina were regionally epizonally metamorphosed. The products of this metamorphism are the gondites. Their specific features allow to consider these rocks as related to the grade of green schists (albite-muscovite-chlorite subgrade). The characteristic assemblage: rhodonite-rhodochrosite-spessartine. The initial, primary rocks were probably clastic-clay sediments enriched by pyroclastics and silica. The deposition of these sediments was synchronous with the latest acts of volcanic activity, widely developed in geosyncline basin.

Technical Session II

September 25, 1974, Hotel International, Concordia Room

Chairmen: WARREN L. ANDERSON (Brazil) and V. PANAYOTOV (Bulgaria)

10. *Manganese in water and sediments of Atlantic Ocean*; by E. M. EMELYANOV, Atlantic Division of Institute of Oceanology, Academy of Sciences of USSR, Prospect Mira 1, Kaliningrad 236 015, USSR.

Geochemistry of manganese were studied in the basin of Atlantic Ocean, including seas: Baltic, Black, Mediterranean. The concentration of manganese was determined by kinetic method [ORADOVSKIY, 1964. YAZIMIRSKIY *et al.*,

1971, EMELYANOV and VLASENKO, 1972] in 520 samples of sea and interstitial suspended matter, in 560 samples of water suspended matter, in stream waters of Baltic basin (20 samples) and hot spring water samples and that of lakes, streams of Iceland (12). The concentration of manganese was determined by wet chemical methods in 1060 samples of bottom sediments, and in 70 samples of them were analysed for mobile forms of Mn^{4+} . Author compiled lots of maps, sections, diagrams which allow to illustrate the main problems of supplying of Mn into ocean, concentration of this element in water, distribution in the different types of sediments and on the bottom and to identify the mineral forms of Mn in sediments.

In stream waters of Soviet Baltic area manganese content in dissolved form: from traces to 3 mkg/l, this value is lesser than that for concentration of dissolved manganese in sea water. Manganese concentration in the studied hot springs, lakes, and streams in Iceland as well as the shallow sea water of adjoining part of ocean: traces to 7 mkg/l. In North Atlantic concentration of dissolved manganese increased from Sargasso Sea (traces to 3 mkg/l) toward the coast (9—11 mkg/l). Concentration of Mn in deep ocean waters is approximately the same as in surface ones. In Baltic Sea and in Black Sea concentrations of dissolved manganese sharply increased from surface (traces to 10 mkg/l) to the bottom (to 1050 mkg/l). In many cases the content of dissolved manganese lowered in the zone of photosynthesis and in the transition zone, in result of biological activity of plankton. The main form of manganese in sea water — presence in solution. In the waters of open ocean the mean concentration of suspended Mn: 0,01—0,05 mkg/l or 8,1—0,5% of total amounts in shallow waters of Baltic Sea mean concentration: 1—4 mkg/l or 10—50%.

In seas with hydrosulfide contamination the amount of suspended manganese increased at the border of sharp decreasing (or complete disappearance) of O_2 and presence of H_2S . The suspended material of off-shore regions and deep-seated layers of the sea water are enriched in manganese again, in the course of sorption of this element by particulated material.

In upper parts of oceanic sediments manganese concentration: traces to 3,14%, mean: 0,10%. The lowest values of Mn were determined in shelf diatom sediments (0,01%) and glauconite sediments (0,02%), the highest concentrations in red clays (0,40%). Manganese in sediments increasing (excluding volcanic regions) with the higher concentrations of the clay fraction, in these sediments extending the distance from the coast and with depth increasing. This phenomenon is the result of increasing of fraction of mobile form of Mn^{4+} (from 0—10% in near shore sediments to 30—90% in pelagic muds). Detrital form of Mn are approximately constant.

Mean concentration of manganese in volcano-clastic sediments of the North Atlantic is 0,15%, in sediments of rift zones, composed by ultramafic fragments — 0,13%. The manganese in these sediments is present mainly in detrital form.

The major source of manganese in the ocean is terrigenous material. The volcanism does play in supplying of manganese into ocean a secondary role. This role in the Atlantic is lesser than in the Pacific Ocean.

11. *The Azul Manganese deposit, Serra dos Carajas area, Southern Amazon region, Brazil*; by WARREN L. ANDERSON, Companhia Meridional de Mineracao, Av. Presidente Vargas 529—9º, C. P. 2857-zc-00, Rio de Janeiro, Brazil.

In the presented paper it was described a formerly unknown region of rather promising manganese ore deposits. The author showed in a very evidential form the main structural pattern of the Azul deposit, the localization of manganese mineralization in the primary carbonate strata, and particular role of relatively older metavolcanic Lower Proterozoic rocks as a source of manganese for carbonate shallow water accumulations. On the Precambrian rocks are developed the lateritic weathering crust, containing huge amounts of manganese oxide minerals, of economic importance. The special interest of the paper is the description of successive formation of manganese accumulations with the progressive enrichment of ore's grade: basic metavolcanites with notable content of manganese; — carbonate strata, containing manganocalcite, rhodochrosite ores, — laterite accumulations with high grade oxide manganese ores.

12. On the mechanism of formation of Obrochishte manganese deposit, Lower Oligocene, Varna region, Bulgaria; by I. K. NACHEV, Geological Institute of the Academy of Sciences of Bulgaria, Sofia, and LILIAN NACHEVA, NIPRORUDA, Stambolijski Squ. 205, Sofia, Bulgaria

The authors presented data on structure, mode of occurrences of Lower Oligocene manganese deposit Obrochishte. The ores are represented by two main phases: carbonate (calcium-rhodochrosite-manganocalcite) and manganese silicate minerals, composing pisolites and other sorts of globuls and in many cases clay-like cement. The lower and upper contacts of 10 m thick manganese ore horizon are of erosional unconformity. The manganese ore-bearing horizon is developed over the vast area of Paleogene depression. The approximate reserves of Mn in this region are about 2×10^9 tons of Mn. The authors suggested the sedimentary-diagenetic origin of this deposit.

13. The experimental data on the study of mechanism of manganese ore formations in recent basins; by I. M. VARENTSOV, Geological Institute, Academy of Sciences of USSR, Pyzhevskiy pereulok 7, Moscow 109 017, USSR

In the paper data of direct observation in nature on the main factors controlling the process of formation of manganese, ferromanganese ores in Recent Basins were presented. These observation serves as a basis for the experimental researches. It was given a brief description of experiments with sea water solutions containing Mn, Fe, Ni, and Co in the form of complex compounds and added sorbents: synthetic hydroxide of Mn and Fe (δ - MnO_2 ; γ - $FeOOH$) In result of such interaction it was received newly formed hydroxide compounds of these elements, mainly as non-stoichiometric solid solutions, spinel-like compounds, depending on the relationships of amounts of this elements in the initial solution. The data obtained allow to suppose that the process are complex, multistage interaction. The following stages may be identified: 1) Ion-exchange stage of highly selective sorption, with equivalent releasing of H^+ into solution; 2) Stage of oxidation of the sorbed elements and formation of hydroxide compounds at the interphase: solid — solution; 3) Stage of dehydration, compaction and partial recrystallization.

Chemosorption plays the leading role with an autocatalytic oxidation process of accumulation of the studied transitional metals. The newly formed phases act in the subsequent cycles of interaction as active sorbents.

The papers presented at the technical sessions of the Commission on Manganese cover a wide area of the geology, geochemistry and mineralogy of manganese, and the papers delivered and the discussions thereafter may be considered as a sign of increasing interest of the geologists in the many-sided and various topics of the manganese researches.

REPORT ON THE BUSINESS MEETING OF THE COMMISSION
ON MANGANESE, 4TH IAGOD SYMPOSIUM, VARNA-GOLDEN SANDS,
BULGARIA, SEPTEMBER 25, 1974

GY. GRASSELLY and I. M. VARENTSOV
President Secretary

The Business Meeting was chaired by PROF. GRASSELLY, President of the Commission on Manganese and the IAGOD Council was represented by DR. D. F. SANGSTER, Treasurer of IAGOD, Secretary: Dr. I. M. VARENTSOV, Secretary of the Commission on Manganese. About 30 persons attended the Business Meeting.

The Chairman welcomed the participants and proposed for discussion the following agenda:

1. Report of the Secretary on the activity of the Commission since the Montreal Meeting:
 - a) Information on the organization of the 2nd International Symposium on the Geology and Geochemistry of Manganese during the 25th IGC to be held in 1976, Sydney, Australia,
 - b) Information on the present stage of organization of an International Monograph on the Geology and Geochemistry of Manganese,
2. Election of Officers of the Commission on Manganese for the period 1974—1978.

The agenda proposed by the chairman were accepted by the Business Meeting. The Secretary submitted the reports as mentioned above.

1. The Commission on Manganese was established at the 2nd IAGOD Symposium in 1967 in St. Andrews (Scotland). The first technical session and business meeting of the Commission was organized in Tokyo-Kyoto during the IMA-IAGOD Meeting, 1970. The second ones were organized during the 24th International Geological Congress in 1972 in Montreal (Canada). According to the decisions of the Montreal Meeting the Management of the Commission on Manganese has had to solve the main tasks:

- Organization of the 3rd Technical Session and Business Meeting during the 4th Symposium of the IAGOD, 1974, Varna, Bulgaria;
- Preparation of the 2nd International Symposium on the Geology and Geochemistry of Manganese during the 25th International Geological Congress, 1976, Sydney, Australia;
- Preparation of an International Monograph on the Geology and Geochemistry of Manganese and as the first step the organization of an Editorial Board.

Details on the activity and plans of the Commission on Manganese are reported in „Letters of the Commission on Manganese (IAGOD)” published in Acta Mineralogica-Petrographica Universitatis Szegediensis, vol. XIX—XXI (1969—1973).

Considering the results of the technical sessions it may be stated that the first item of the planned program is completed.

a) Informations on the organization of the 2nd International Symposium on the Geology and Geochemistry of Manganese, 25th IGC, 1976 Australia.

General Statement; The goal of the Symposium is to review the advances on the field of manganese geology and geochemistry during the last 20 years, since the Mexican Symposium on Manganese, 20th IGC, 1956, Mexico.

The main sections of the Symposium;

Geology of Manganese Deposits,
Mineralogy and Geochemistry of Manganese,
Manganese on the Floor of Recent Basins (Geochemistry, Mineralogy, Ore Deposits and Metalliferous Muds). The session of the last section is organized as a joint session by the IAGOD Commission on Manganese and the IUGS Commission for Marine Geology, as a part of the Commission for Marine Geology Symposium: Economic Geology of the Sea Floor.

Time of the Symposium; Conforming to the proposed schedule of the 25th IGC (1st Circular p. 7) the Symposium on the Geology and Geochemistry of Manganese could be held in the following days (1976):

August 17, Tuesday,	14.00—17.00	Technical Session
August 18, Wednesday,	14.00—16.00	Technical Session
	16.15—18.00	Business Meeting
August 19, Thursday,	14.00—17.00	Technical Session ⁺
August 20, Friday,	14.00—17.00	Technical Session

(⁺The programme for this day is already compiled. It will be a joint session of IAGOD Commission on Manganese and IUGS Commission for Marine Geology.)

Time allocated for the presentation of papers is 20 minutes and 10 minutes for discussion.

Detailed information on the Symposium's Programme will be prepared for publication in the 3rd Circular of the 25th IGC.

Participation in the Symposium. The Symposium on the Geology and Geochemistry of Manganese will be held in course of the 25th IGC and participation in the IGC provides the possibility for the interested persons to attend the sessions of this Symposium.

Conveners of the Symposium on the Geology and Geochemistry of Manganese;

Section I Geology of Manganese Deposits

DR. JOHN VAN N. DORR II, 6220 Wiscasset Road,
Washington, D. C. 20016, U. S. A.

PROF. DR. SUPRIYA ROY, Dept. of Geology, Jadavpur University, Calcutta
32, India

Section II Mineralogy and Geochemistry of Manganese

PROF. DR. RONALD SOREM, Dept. of Geology, Washington State University,
Pullman, Washington, 99163 U. S. A.

PROF. DR. R. GIOVANOLI, Inst. für anorg. anal. und physikalische Chemie,
Universität Bern, P. O. B. 140, CH-3000, Bern 9, Switzerland

Section III Manganese on the Floor of Recent Basins

DR. D. S. CRONAN, Imperial College of Science and Technology, Prince Consort Road, London SW 7 2BP, United Kingdom

PROF. DR. E. SEIBOLD, Geologisch-paläontologisches Institut der Universität Kiel, Olshausenstrasse 40/60, Kiel, F. R. G.

DR. I. M. VARENTSOV, Geological Institute, Academy of Sciences of USSR, Pyzhevskiy pereulok 7, 109017 Moscow Zh-17, USSR

The organizational work of the Commission concerning the 2nd Symposium on Manganese will be supported also by the Australian domiciled contact Representative of the Commission, DR. D. G. MOYE, Director of Exploration, The Brocken Hill Proprietary Co. Ltd., BHP House, 140 William Street, Melbourne, Victoria 3000, Australia.

The Business Meeting approved the list of conveners proposed.

b) Information on the present stage of organization of an International Monograph on the Geology and Geochemistry of Manganese and on the preparation and presentation of papers.

Preparation and presentation of papers. As it was mentioned above, the Symposium on Manganese will be organized in course of the 25th IGC. Abstracts of papers presented at the Symposium are planned to be published in the IGC Volume of Abstracts. Each contributor should submit a detailed abstract of his/her paper to the Conveners of the corresponding section BEFORE JULY 1, 1975.

After evaluating the papers submitted authors will be asked to submit the paper's manuscript BEFORE FEBRUARY 1, 1976. The papers accepted and included into the Programme of the Sections as well as further papers not delivered at the Section's Sessions, general review works reflecting the advances in the study of geology, geochemistry and mineralogy of manganese during the last 20 years may be selected for publication in the International Monograph on the Geology and Geochemistry of Manganese.

The *International Monograph on the Geology and Geochemistry of Manganese* will be published according to plan in two volumes:

Vol. I General problems (about 400 pp)

Vol. II Geology of Manganese Deposits (about 500 pp).

PROF. GRASSELLY, President of the Commission on Manganese entered into correspondence with the Publishing House of the Hungarian Academy of Sciences (Budapest) as well as with the Schweizerbart'sche Verlagsbuchhandlung (Dr. Nägele, Stuttgart, F. R. G.). July 16, 1974 the President and the Secretary, DR. I. M. VARENTSOV carried on negotiations with the Deputy Director of the Publishing House of the Hungarian Academy of Sciences concerning the publication of the Monograph planned. A very reassuring and satisfactory preliminary agreement was achieved. The Monograph will be issued by the Publishing Houses mentioned in co-operation.

After preliminary correspondence and talks with leading manganese geologists the Management of the Commission on Manganese makes a proposal for the *Editorial Board*;

Editor in chief: DR. I. M. VARENTSOV (USSR)

Editors: DR. D. S. CRONAN (U. K.), DR. J. E. CUDJOE (Ghana), DR. J. V. N. DORR (U. S. A.), PROF. DR. S. ROY (India), PROF. DR. R. SOREM (U. S. A.), DR. H. WALTER, (F. R. G.)

Members of the Editorial Board: PROF. DR. GY. GRASSELLY (Hungary), PROF. DR. H. PÉLISSONIER (France) , DR. V. P. RACHMANOV (USSR), PROF. DR. E. SEIBOLD (F. R. G.)

The proposal concerning the Editorial Board was approved by the Business Meeting.

2. Election of the Officers of the Commission on Manganese for the 1974—1978 period.

The chairmanship was taken over from PROF. GRASSELLY by DR. D. F. SANGSTER, representative of the IAGOD Council. On behalf of the IAGOD Council, DR. SANGSTER appreciated the activity and efforts of the Commission on Manganese which proved to be one of the most successful among the Commissions and Working Groups of the IAGOD. In the next two years the Commission on Manganese looks forward again to fairly hard duties: organization the 2nd International Symposium on Manganese and the edition of the International Monograph on the Geology and Geochemistry of Manganese. Therefore, it is proposed by the IAGOD Council that the present officers be asked to continue in their post and complete the programme started and promoted by them.

DR. SANGSTER'S proposal was accepted by the Business Meeting and the Officers were elected for the period 1974—1978:

President: PROF. DR. GY. GRASSELLY (Hungary)

Vice-President: DR. JOHN VAN N. DORR (U. S. A.)

Vice-President: PROF. DR. SUPRIYA ROY (India)

Secretary: DR. IGOR M. VARENTSOV (U. S. S.R.)

After the election Prof. Grasselly, President of the Commission on Manganese expressed his gratitude to the participants of the Business Meeting for their confidence and asked for their active co-operation in the future.