

# In Memoriam

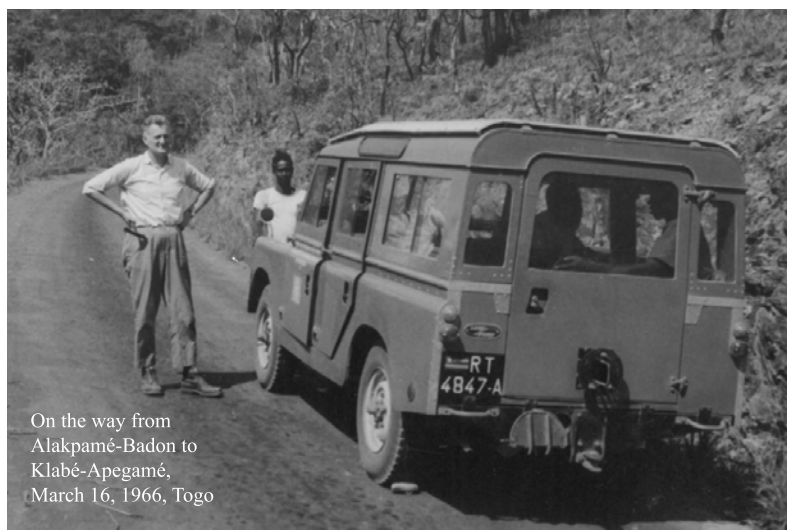
## Professor Emeritus Ivan Jurković

### Fellow of Croatian Academy of Sciences and Arts

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On the way from Alakpamé-Badon to Klabé-Apegamé, March 16, 1966, Togo

Fellow of Croatian Academy of Sciences and Arts Ivan Jurković, professor emeritus of Economic geology (Ore petrology) and Ore microscopy at the Faculty of Mining-Geology-Petroleum engineering, and former Rector of University of Zagreb (1978-1982), passed away quietly in his home in Zagreb, on the 30 December, 2014. He was a founder of modern studies in the field of ore genesis and metallogeny in Croatia, and an outstanding lecturer, among the best teaching geology in Croatia.

Professor Jurković was born on 27 March, 1917 in Ogulin. He attended the elementary school (1923-1927) and the high school there, then the Gymnasium, (1927-1935) in Zagreb. He obtained his BSc degree in chemistry at the Technical Faculty in Zagreb in 1939, and BSc degree in geology at the Philosophical Faculty in Zagreb in 1942. In 1956 he completed his PhD thesis at the Technical faculty, University of Zagreb, under supervision of the Academician Luka Marić. The title of the thesis was „Mineral parageneses in the Bosnian schist mountains with special reference to mercury, gold and silver bearing tetrahedrites“. He habilitated in 1957 (Veniam docendi thesis) at the Faculty of Technology in Zagreb with the theme „Metallogeny of Petrova Gora Mt., SW Croatia“ in the framework of the course entitled „Ore deposits“ (Economic Geology). His teaching career began as an assistant at the Department of Mineralogy and Engineering geology at the Technical Faculty of Zagreb University (1939-1942). From 1942 until the end of World War II in 1945 he volunteered in the same department under prof. Miroslav Tajder. In the following years he worked continuously in the Mineralogical-Geological department of the Technical faculty, as an assistant (1945-1957), then as assistant professor (docent), 1957-1959, associate professor (1959-1963) and full professor (1963-1987), after which he retired. In 1969 he was elected as a full member of the Croatian

Academy of Sciences and Arts (former Yugoslav Academy of Arts). He was promoted to the position of Rector of Zagreb University for 1978-1982, and acted as the President of the Parliamentarian Council for education, science, culture and sport of Republic of Croatia between 1982. and 1984. He obtained the honored title of Professor emeritus of Zagreb University in 2000.

Geological investigations of prof. Jurković covered, beside all republics of the former state, a vast global territory in Africa, Asia and South America. In the educational, social, and political domains, he undertook many high-ranking duties (see the Appendix).

His fruitful and productive life, characterized by complete devotion to science and care for the education of many younger generations of geologists, is like a lighthouse beacon to his followers. His inventive and motivating lectures paved the way for many professional geological careers. Those who were lucky to have learned from or worked with prof. Jurković, including me (LP) as his assistant and co-worker in semi centenary cohabitation, have had a chance to learn honest and strong principles of scientific ethics. He was a firm fighter for his scientific ideas but a fair opponent in arguments without any trace of vanity or vengefulness. He was well-known for his extraordinary appreciation of past and contemporary investigations in the field of interest, so his published papers are the richest source of relevant references and citations. His remarkable scientific career over the century is marvelous example of the freshness of his logic and open-mindedness to new principles of global tectonics, which he successfully applied in the field of ore geology.

We feel sorrow for the loss of our teacher who guided and encouraged us in the time when science was not, and still is not, a primary interest in our homeland. The followers of Professor Ivan Jurković also lost an open-hearted and honest critic of our work, and an objective and corrective judge. We give our sincere gratitude for all those moments of simply being and working with him, and promise to keep the human and scientific standards established by this extraordinary personality.

In addition to more than 200 scientific papers (almost 90 published internationally) he was also interested in many other human activities. A complete list of his scientific papers was published in the Vol. 68/2 of Geologia Croatica (Garašić & Durn, 2015). As a Memento of his extensive activity in scientific, educational, research and social domain is presented in the Appendix of this Necrology (part of biography of academician Ivan Jurković retrieved from Croatian Academy of Sciences and Arts [info.hazu.hr/upload/file/.../IJurkovic\\_biography.doc](http://info.hazu.hr/upload/file/.../IJurkovic_biography.doc)).

Ladislav Palinkaš and Vladimir Bermanec

**APPENDIX****Functions in the United Nations (UNDP, N.Y.)**

29.01.1965.-16.04.1968. On the request of the Tunisian Government, the Office de mines Tunisia, United Nations (UNDP) appointed Jurković as geologue en chef (expert) of the project "Prospection minerale du Bassin de la Foussana en Tunisie Centrale" with residence in the town Tunis, Tunisia. During this period UN entrusted him with the inspection of UNDP project (one month 1966.) titled: "Pegmatites and gold-bearing quartz veins in the Northern Benin", (ex Togo) Central Africa. In the same year (1966) Jurković, with the agreement of UN, studied (for three weeks) huge lead-zinc bearing barite deposits in the region of Ouida, Eastern Morocco, on account of comparison with Tunisian deposits. During his employment in the United Nations Jurković utilized his 2 month annual holiday to undertake for free, his educational commitments as professor of Zagreb University.

**Employments and functions in the Croatian Parliament and Government**

15.05.1947.-11.11.1949. Director and chief geologist of the Geological Institute in the Ministry of industry and mining of the Croatian Government.

11.11.1949.- 01.05.1951. Chief geologist of the Ministry of black (Fe, Mn) and coloured (Cu, Pb, Zn) metallurgy in the Yugoslav Federal Government, Belgrade.

1967-1971 Member of Croatian Parliament (Sabor) for the communes of Ogulin and Vrbovsko in the Social-political Council and in the Cultural-educational Council.

1968-1978 Member of the Executive Council (IV Sabora, Croatian Government) responsible for science, informatics and technology.

1971-1975 Director of the Republican Fund for scientific investigation and president of the Croatian scientific Council.

1971-1978 Delegate of the Croatian Government in the Federal Committee for science and culture, Belgrade.

1978-1982 President of the newly formed Parliamentarian Council for education, science, culture and sport in the Croatian Parliament.

During all of the aforementioned duties, Ivan Jurković executed for free, his educational commitments as a professor of Zagreb University.

**Honours, decorations, diplomas of honorary memberships, recognitions Decorations**

2012. Orden reda Danice Hrvatske s likom Ruđera Boškovića (Order of Danica Hrvatska with the effigy of Ruđer Bošković)

1987. Orden Republike Hrvatske sa zlatnim vijencem (Order of the Republic of Croatia with golden wreath)

1977. Orden zasluga za narod sa zlatnom zvijezdom (Order of merits for the people with golden star)

1974. Orden Republike Hrvatske sa srebrnim vijencem (Order of the Republic of Croatia with silver wreath)

1964. Orden rada sa zlatnim vijencem (Order of labour with golden wreath)

1953. Orden rada sa srebrnim vijencem (Order of labour with silver wreath)

1948. Medalja za zasluge za narod (Medal for merits for the people)

**Memberships in HAZU (JAZU) and ANU BiH**

1963-1969 Corresponding working member in the Yugoslav Academy of sciences and arts (JAZU)

1969-1991 Ordinary member (academician) of JAZU

1991-2012 Ordinary member (academician) of Croatian Academy of sciences and arts (HAZU)

1973-2012 Corresponding member of Bosnian and Herzegovian Academy of science and arts (ANU BiH) Sarajevo

1969-1972 Member of the JAZU Presidency

**Medals obtained of foreign universities and societies**

1988. International Committee for Studies of Bauxites, Alumina, Al-oxides, residence in HAZU, Zagreb

1984. Kijevskij Gosudarstveni Univ. T.G. Sevčenko, Kijev

1984. Re-solution given by State of Florida, Tallahassee

1983. Universitatis Jagellonica Cracoviensis, Krakow

1982. Universita degli Studi di Trieste, Trst

1981. Moskovskij Avtomobil-nodoroženij inst., Moskva

1981. Alma Universitatis Graecensis-Carola Francisca, Graz

1981. American Council on Education - MCMXVIII, Washington

1981. Technische Universitat, Dresden

1981. Hamburgische Universität, Hamburg

1981. Universitatis studiorum, Freiberg

**Memberships and functions in the foreign and national scientific and professional societies, associations and organizations****In foreign countries**

2012-1963 Member, and from 1988.-1983 President of the International Committee for the study of Bauxite, Alumina and Al-oxides (ICSOBA), Zagreb, Croatia

2012-1991 and 1976-1968 Member of the Society for applied geology deposits (SGA), residence in Prague, Czech Republic

2012-1991 and 1976-1968 Member of the International Association on the genesis of the ore deposits, Commission of the ore parageneses CPa (IAGOD)

2000-1993 Member of the Union of geosciences (EUG), Strasbourg, France

2000-1997 Collaborator of the International Biographical Center (IBC), Cambridge, United Kingdom

1989-1988 Coordinator of the IGC Project No 287., UNESCO, Paris; Correlation of Mesozoic-Tertiary bauxites and related Paleokarst phenomena in the Tethyan Realm

1989-1982 Member of the Joint Yugoslav-American Advisory Council and Academic Committee, Florida State University, USA

1989-1983 Coordinator for the Cooperation in Natural and Technical Sciences between Florida nad Yugoslavia

1985.-1980. Member of the Administrative Board (Executive Committee) of the International Association of the Universities, Paris, France

1984-1981 Member of the Executive Committee for the Cooperation between ACE (American Council on Education) and ZUJ (Union of Yugoslav universities)

1974-1971 President of the Scientific Council of the United Nations International center for the enterprises in the public property, Ljubljana, Slovenia

1978-1974 Member of the Administrative Board of the International Center for Mechanical Sciences (CISM), Udine, Italy

1978-1968 Glied der Deutschen Mineralogische Gesellschaft  
1974-1971 President of the Norwegian-Yugoslav friendship society

1972. Delegate of the Federal Geological Institute and of the Union geological societies at the World Congress of petroleum and gas in Moscow; 1968. at the Geological World Congress in Prague and in 1964 at the Geological World Congress in New Delhi, India.

1968-1965 „Geologue en chef“ of the United Nations project in Tunisia

1966. Adviser to the United Nations Project in Benin (ex-Togo, Central Africa)

## EDUCATION ACTIVITIES

### Education of PhD and MSc candidates

(a) Jurković was the mentor of the following PhD candidates: Boris Šinkovec (full professor, Faculty of Mining, Geology and Petroleum Engineering, researcher in Venezuela and Tunisia), Karlo Braun (lecturer at the Faculty of Organization and Informatics, Varaždin), Josip Crnički (assistant professor at the Faculty of Organization and Informatics, Varaždin, researcher in Tunisia and Kenya), Božidar Zalokar (senior lecturer, Faculty of Mining, Geology and Petroleum Engineering, UN expert in Egypt for three years, researcher in Myanmar (Burma), Indonesia, Nepal, India), Ante Ferenčić (UN expert in Panama for three years, researcher in Myanmar (Burma), Venezuela and Ethiopia), Dubravko Šiftar (assistant professor, Faculty of Mining, Geology and Petroleum Engineering), Ladislav Palinkaš (full professor, Faculty of Mining, Geology and Petroleum Engineering and Faculty of Science, researcher in Indonesia (Kalimantan) and Kurdistan (Iraq), associate member of Croatian Academy of Sciences and Arts), Mehmed Ramović, (member of ANU BiH, full professor, Faculty of Science, Sarajevo), Rade Vasiljević (counsellor for geology in Belgrade).

(b) Jurković was the mentor of the following MSc candidates: B. Šinkovec, D. Šiftar, L. Palinkaš, B. Zalokar, V. Podubsky, K. Braun, B. Šebečić, R. Tončić-Gregl, D. Krkalo, Kapusta, Pruthi, etc.

(c) Jurković was the mentor in the education of geologists in the Office des Mines in Tunisia: T. Ghozi and H. Handous (within the UN project from 1965 to 1968).

### Building new research and teaching centres

University Computing Centre (Sveučilišni računski centar - SRCE) of the University of Zagreb

National and University Library in Zagreb (Nacionalna i sveučilišna knjižnica u Zagrebu - NSK)

“Bjelolasica Ski Resort” 30 km west of Ogulin in Gorski Kotar  
Science-Educational Centre at the Island of Lokrum near Dubrovnik

Molecular Biology Centre in the Franciscan Monastery Rožat in Gruž near Dubrovnik

Hvar Astronomical Observatory for observation of the Sun

## SCIENTIFIC ACTIVITIES IN THE GEOLOGY OF ORE DEPOSITS

### Realized scientific projects and investigations financed by Ministry of Science and Technology of the Croatian Government (1993-2012)

1) Metallogeny of Paleozoic in Croatia, Western and Middle Bosnia (No 1-09-050), guide: Ivan Jurković (1993-1995)

2) Magmatism, metamorphism and ore deposits of the Dinarides (No 119-393; 1996-2002), guide: Ladislav Palinkaš

3) Geology and metallogeny of the Dinarides (2002-2007), guide: Jakob Pamić (2002-2004) and Ivan Jurković (2004-2007)

4) Geochemistry of mineral deposits in the Dinarides and their influence on water in Karst, guide: Ladislav Palinkaš (2007-2012)

### Realized scientific projects (1981-2001):

1)1983 Bergakademie, Freiberg, DDR, Theme “Erfahrungsaustausch in der Erzlagerstättenlehre und in den Methoden der wissenschaftlichen Bearbeitung der Erzlagerstätten, Studium der Metallogenese”

2) High Technical Scoole, Košice, Slovakia, ČSSR: Theme: “Comparative study on metallogeny of Dinarides and Tatra”

3) Uniwersitet Jagellonski, Kraków, Poland: Theme: “Comparative study on metallogeny of Western Carpathian and Dinarides”

4) 1981. Florida State University (FSU), Tallahassee, Florida, USA: Theme: “Tracing karstic waters by uranium isotopes”

5) International Geological Correlation Programs (IGCP), UNESCO, Paris (1987-1992): Project No 287: “Correlation of Mesozoic Tertiary bauxites and related Paleokarst phenomena in the Tethyan Realm”. Jurković and dr. Andrea Mindszenty from Eötvös Loránd University, Budapest as coordinators organized this project which attended scientists from Spain, France, Italy, Austria, Hungary, ČSSR, Romania, Greece, Turkey, Egypt, Iran, and as opserves scientists from China, India, Jamaica, USA and Federal Republic Germany



- 6) UNESCO, Paris, IGCP-291, (1993-1998): Metamorphic Fluids and Mineral Deposits
- 7) UNESCO, Paris, IGCP-356, (1993-1996): „Plate Tectonic Aspects of the Alpine Metallogeny in the Carpatho-Balkan Region
- 8) UNESCO, Paris, IGCP-369 (1996-1998): “Comparative Evolution of Peritethyan rift Basins”
- 9) PANCARDI Project 2000-2001: Theme ”Pannonian Basin, Carpatho–Dinaridic Systems, dynamics of ongoing orogeny”
- 10) Eötvös Loránd University, Budapest (Hungary) (1995-1998): Theme: “Comparison of bauxites deposits between Hungary and Yugoslavia”
- 11) Projects within Society for Geology Applied to Mineral Deposits (SGA), Freiberg, Germany: a) Mineral Deposits. From their origin to their environmental impacts (1993-1995), b) Mineral Deposits. Research and Exploration where do they meet (1996-1997), c) Mineral Deposits. Processes and processing (1998-1999), d) Mineral deposits and the Beginning of the 21st Century (2000-2001)

#### THE MOST IMPORTANT RESULTS OF PROF. JURKOVIĆ RESEARCH WORKS IN METALLIC AND NONMETALLIC ORE DEPOSITS

##### Ore deposits investigated in detail by field and laboratory methods and prepared for exploitation, located in foreign countries

- 1) A big copper deposit Monywa, Republic Mianmar (ex-Burma)
- 2) Gold bearing copper deposits in the Indonesian islands of Sumatra and Sulawesi
- 3) Tertiary lead-zinc deposit Oum Geigh at Qosseir on the Red Sea Shore, Egypt
- 4) Lead-zinc-bearing barite, fluorite deposits on the El Kef region, Tunisia
- 5) Lead-zinc deposits Djebel Azered, Djebel Hamra and Djebel Agab in the Foussana Basin, Tunisia (UN Project)
- 6) A huge iron (itabirite) deposit at San Isidro, Republic of Venezuela with one billion tonnes of iron ore

##### In the Republic of Croatia

- 1) Barite deposits in the Lika, Gorski Kotar and Petrova gora Mountain
- 2) Copper bearing siderite deposit of Gradski Potok and the lead-zinc-bearing siderite deposit of Zrin in the Trgovska gora Mountain
- 3) Hematite ore deposit of Bukovica, Petrova gora Mountain
- 4) Pliocene limonite deposit at Meterize, Bešlinac, Trgovska gora Mountain
- 5) Magnetite-hematite occurrences (itabirite) of Adolfovac, Zagrebačka gora Mountain
- 6) Bauxite deposits in Northern Dalmatia

##### In Bosnia and Herzegovina

- 1) Metasomatic monomineral barite deposits in the Devonian carbonate rocks in the Tarčin, Kreševo, Kiseljak, Brestovsko, Fojnica, Deževica, Dusina, Sabiljine Pećine, Rostovo regions (MBSM)
- 2) Veiny mercurian-tetrahedrite-bearing barite-siderite deposits in the Silurian and older schists, and sandstones in the Mačkara and Mračaj deposits
- 3) Bakovići (Fojnica); the richest pyrite-siderite gold veiny deposit
- 4) Čemernica (Fojnica); a rich silver-bearing zinc-antimony deposit
- 5) Vrtlasce (Fojnica); a cassiterite-bearing magnetite, pyrrhotite, lead-zinc deposit
- 6) Hrmza (Kiseljak); a realgar and orpiment deposit
- 7) Magnetite, hematite, siderite, ankerite, chalcopyrite and arsenopyrite deposits, Mačje jame, Busovača
- 8) Lead-zinc-copper bearing barite deposits in the Prača region, South-east Bosnia

##### Bauxite deposits in the ex-Yugoslavia

Jurković and Sakač exhibited in 1963 the first stratigraphic position, morphology parageneses and geneses of all bauxite deposits known at that time throughout the ex-Yugoslavia. A lecture was held on the foundation day of the International Committee of Study of bauxite, alumina and Al-oxides (IC-SOBA) in the HAZU Palace, Zagreb.

##### Evaporites in the Western Dinarides

The most important gypsum and anhydrite deposits localized in the Western Dinarides differ by their isotope  $\delta^{34}\text{S}$  values depending on their age of formation. The large and widespread Upper Permian evaporites found in Northern Dalmatia, in the Una, Sana and Vrbas valleys are characterized by  $\delta^{34}\text{S}$  values of +11.02‰ (61 samples), most of them between +9.0 to +12.5‰. These values are almost identical to the isotopic values of sulphates in Permian sea water. Relatively small sized, the deposits are locally distributed on the islands of Vis and Palagruža, in the Sinj, Bistrica and Vareš regions. Lower Triassic evaporites distinguish high average  $\delta^{34}\text{S}$  values of +23.3‰ (27 samples), mostly between +20.9 to +25.6‰. Lower Cretaceous evaporites are found only in deep holes of the Adriatic realm, on the islands of Vis, Brač, Dugi Otok, Olib, Krk, Susak, Lastovo and in North Dalmatia. They show  $\delta^{34}\text{S}$  values of +16.77‰ (105 samples), ranging from +14 to +18‰. Synthesis relating to the evaporites from the Western Dinarides was presented at the 3rd Biennial Meeting of the SGA in Prague and published in the Balkema Publ., Rotterdam; JURKOVIĆ & ŠIFTAR, 1995 (article No 144).

##### New hypothesis concerning the Hercynian metallogeny in the Dinarides

In the period from 2007 to 2011, Jurković was first to use the previously unapplied modern geochemical and other physico-chemical analyses to the investigation of rhyolites and minerals from the all paragenetic types of ore deposits in the

NW-MID-and SE Bosnia. Results of these numerous analyses provided very convincing responses to the earliest mostly unsolved problems.

(1) The rhyolite magmatism located in the Mid-Bosnian Schist Mountains (MBSM) is not of juvenile origin, but rather originates from partially melted (anathexis) Neoproterozoic and Lower Palaeozoic rocks as protoliths and therefore the mineralization took place from the metamorphogenic fluids.

(2) The most interesting problem for researchers was the presence, of two very strongly different paragenetic types of barite or barite-siderite deposits. The first paragenetic type distinguishes Fe, Cu, Zn, Pb, As and Sb sulphides and sulphosalts, all without mercury characterized by low  $\delta^{34}\text{S}_{\text{CDT}}$  values (0-5 ‰). Barite crystals distinguish a Variscan fluid system: NaCl-H<sub>2</sub>O or NaCl-KCl-H<sub>2</sub>O (low  $T_h$  and low salinity). With the  $\delta^{34}\text{S}_{\text{CDT}} = 11$  ‰,  $\delta^{18}\text{O}_{\text{SMOW}} = +14$  ‰.

The second paragenetic type of barite and barite-siderite deposits distinguishes mercurian tetrahedrites (with 0.34 to 7.58 wt% Hg) as the unique main ore mineral.

All analysed tetrahedrite samples (n=22) show strongly negative  $\delta^{34}\text{S}_{\text{CDT}}$  values ranging from -4.95‰ to -15.40‰. Barite, fluorite and quartz crystals were identified in the post-

Variscan fluid system NaCl-CaCl<sub>2</sub>(+,-MgCl<sub>2</sub>).H<sub>2</sub>O characterized by high  $T_h$  and very high salinity. Oxygen isotope analyses identified a shift to +18 ‰. Strontium analyses of these barite crystals were within the range of values discovered for the first paragenetic type which indicates coeval formation from an identical metamorphogenic fluid, as suggested by JURKOVIĆ in JURKOVIĆ & PALINKAŠ (1999).

(3) During the transition phase within the Uppermost Permian-Lower Triassic, the Early Triassic rifting phase caught hold of the whole of the Dinarides but with very different intensities. The strongest impact affected the most elevated tectonic blocks of the MBSM, much less the SE Bosnia block and only sporadically the NW Bosnia region. The most significant phenomenon of this first phase of Triassic rifting was the ascension of the deep-seated mercury, less fluorine, boron and H<sub>2</sub>S gases and vapours. These vapours and gases under high PT conditions overprinted all types of pre-existing ore deposits, prior to all barite and barite-siderite sulphide deposits. All sulphides were remobilized, partly or completely fluidized and finally recrystallized, building up the mercury component as mercurian tetrahedrite. The strongly negative  $\delta^{34}\text{S}_{\text{CDT}}$  values formed by fractionation between ascended H<sub>2</sub>S and SO<sub>4</sub><sup>2-</sup> derived from evaporites (JURKOVIĆ et al., 2010; 2011; 2012).

