Dedicated to emer. o. Univ. Prof. Dr. Josef Zemann on the occasion of his 90th birthday

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Josef Zemann was born in Vienna, on 25 May, 1923. He grew up in an environment interested in social progress and optimistic regarding technical and scientific evolution. Although the economic situation was characterized by remarkable poverty his parents enabled his attendance at a gymnasium. There he impressed his teachers by his capabilities and they supported his broad interests, not only in natural science, but also in literature, language and music. Due to an eye disease, he was not conscripted into the military and hence was able to enrol in the Philosophical Faculty of Vienna University in the winter semester of 1941, where his main interest was focussed on the natural sciences and mathematics. Based on his good performance in the chemical laboratory he was recommended to the head of the Institute for Mineralogy as research and teaching assistant. This encouraged him to switch from a curriculum leading to a career as a teacher in a gymnasium to pursue instead a path to become a scientist. During his studies, he was strongly influenced by Felix Machatschki, who moved from Munich to become Professor and Head of the Institute for Mineralogy in Vienna in 1944. Under Machatschki's supervision, he wrote his Ph.D. thesis *Über die Struktur des Pharmakosiderits*; this was presented to the Faculty Committee on 21 May, 1946. Shortly after passing the necessary exams, he was awarded the Dr. Phil. degree in Mineralogy and Petrography. From 1946 to 1951, he worked at the institute in Vienna, during which time he completed his 'Habilitation' entitled *Die Mineralien Schafarzikit und Trippkeit*. In 1951, he received the 'Venia Legendi' for Mineralogy and Petrography; this enabled him to give lectures and supervise PhD students independently.

In 1951/52 he received funding from the Austrian government for a research fellowship at the Massachusetts Institute of Technology (MIT) in Cambridge, USA, to work with Martin J. Buerger. At that time, Buerger was the doyen of X-ray crystallography and crystal structure determination in the geosciences and his laboratory was the best place to learn such methods, since Austria and Germany lagged far behind in these techniques. In the US he not only gathered invaluable experience in modern crystallography but also married Anna Hedlik who also had a fellowship at MIT. In 1953, following his visit to the USA, he was appointed Associate Professor and Director of the Institute for Mineralogy-Crystallography at the University of Göttingen, aged only 29. This position was one of only two professorships for crystallography in Germany at that time.

In Göttingen, Zemann, together with his wife and colleague, Anna Zemann-Hedlik, initially concentrated on crystal structure determinations of minerals; he led the field in introducing the methods that he had learned at MIT to Austria and Germany. In 1963, he was promoted to Full Professor in Göttingen, after turning down an offer of a Full Professorship at the University of Münster. In 1967, he was appointed Director of the Institute for Mineralogy and Crystallography at the University of Vienna, as successor to Machatschki; he held this position for 22 years, until his retirement as Professor Emeritus in 1989.

Of the about 40 scientific publications from his work in Vienna and Göttingen up to 1967, fully two thirds concern aspects of crystal-chemistry based on crystal-structure determinations. The other papers dealt with lattice energy calculations, IR-spectroscopy and more general topics such as the crystal chemistry of the elements bismuth and copper, of the garnet group and of tellurium(IV)-oxygen compounds. During this time he also published his textbook *Kristallchemie* (Sammlung Götschen 1220/1220a, W. de Gruyter & Co, Berlin 1966) which was subsequently translated into Russian and French. He also revised the first part

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(*Kristallographie*) of C.W. Correns' textbook *Einführung in die Mineralogie* (Springer, Berlin-Heidelberg-New York, 1968); this was also translated into English and Persian. During the following years he acted as co-editor of the *Handbook of Geochemistry* (Ed.: K.H. Wedepohl, Springer, Berlin-Heidelberg-New York, 1969–1978) where he contributed the general chapter on *Crystal Chemistry* and the four chapters on the *Crystal Chemistry of Carbon, Copper, Selenium, and Tellurium*. His contribution *Cristallochimica* in the *Enciclopedia della Chimica* (USES, Firenze) appeared in 1974. From 1969 to 1978 he served as Chief Editor of *Tschermaks Mineralogische und Petrographische Mitteilungen*, *TMPM*, now *Mineralogy and Petrology*.

With their examination of oriented mineral samples using polarised infrared radiation, Zemann and his co-workers entered a completely new field of mineralogy. This method made the investigation of anisotropy effects in this spectral region possible and here the pleochroism of the OH stretching frequency in minerals was of considerable interest, since the localisation of H atoms by X-ray structure determination was rather difficult in those days.

Other important topics of interest during Zemann's second period in Vienna were the stereochemistry of Cu^{2+} in Cu-O_x polyhedra and the shape of the carbonate group CO_3^{2-} , especially its deviation from planarity. In his contribution to the crystal chemistry of carbon in the *Handbook of Geochemistry* he had already stated that 'No deviations from planar symmetry seem to have been found so far'. The indirectly formulated question which this statement implies was answered some 10 years later. By combining the results from about two dozen publications on carbonates by himself and his co-workers with data from the literature, Zemann was in a position to formulate some rules on the crystal chemistry of carbonates in his paper *Zur Kristallchemie der Karbonate*, concerned with the possible non-planarity of this group. In later years, continuing after his retirement, he completed this work with several publications on theoretical calculations.

Even though he invested an enormous amount of effort into the crystal chemical problems mentioned above, he did not forget his interest in mineralogical and petrographic field work and in spectroscopy whilst Professor in Vienna. Of special interest was the incorporation of hydrogen in nominally water-free minerals as well as the very complex crystal chemistry of this element in general. Examples are the papers about andalusite, the three TiO_2 -modifications, cassiterite, enstatite, and generally about hydrogen in geochemistry and mineralogy. In particular, his co-workers' investigations concerning the OH content in nominally water-free minerals that he initiated and actively accompanied, have consequences which are not yet completely clear. It has been estimated that the water which is stored in such 'water-free' minerals in the upper 660 km of the Earth's

mantle amounts to the volume of the oceans. It is clear that these findings are of great importance for geophysics, geology, and geochemistry.

As of today, with his scientific interests still active, his publication record includes more than 180 contributions; remarkably, his input to all these papers was both vital and inspiring. This record proves that Josef Zemann is one of the leading mineralogical crystallographers of our time.

One point which is always mentioned by his students and colleagues is the elegant and impressive, but nevertheless simple manner in which he distributed his knowledge and experience, not only to students in his lectures but also in his day-to-day scientific work. He never spoke to only the few persons in the audience who really understood the subject; he always managed to reach everyone without reducing the scientific quality of his lecture. I remember a Plenary Lecture about carbonates during a meeting of the German Mineralogical Society where I heard a group of students say afterwards that this was the first time that they had understood what the topic was about at a Plenary Lecture and that they had learned something.

During his time both in Göttingen and afterwards in Vienna before the Iron Curtain fell, Josef Zemann had extensive contacts with colleagues in eastern and south-eastern Europe and he contributed a lot to improve the work and travel conditions of his colleagues there. These efforts have been honoured with medals from several universities as well as membership and honorary membership of a number of Eastern European academies and mineralogical societies. These, together with honours and awards from other international societies and academies are listed below.

Academy memberships, honorary fellowships and awards

1967 Corresponding Member, Österreichische Akademie der Wissenschaften (18.5.1967).

1967 Corresponding Member, Akademie der Wissenschaften zu Göttingen, Germany.

1968 Zemannite approved as new mineral by International Mineralogical Association.

1969 Honorary Fellow, Mineralogical Society of America.

1972 Full Member, Österreichische Akademie der Wissenschaften (16.5.1972).

1974 Gustav-von-Tschermak-Seysenegg-Medal, Österreichische Akademie der Wissenschaften.

1979 Correspondent, Geologische Bundesanstalt, Vienna.

1981 Honorary Member, Österreichische Mineralogische Gesellschaft (19.1.1981).

1982 Member, Academia Mediterranea delle Scienze, Catania, Italy.

1982 Honorary Member, Hungarian Academy of Science.

1982 Honorary Member, Mineralogical Society of the Soviet Union.

1984 Member and Senator, Deutsche Akademie der Naturforscher Leopoldina.

1984 Honorary Member, Mineralogical Society of Poland.

1984 Erwin-Schrödinger-Medal, Österreichische Akademie der Wissenschaften.

1984 Abraham-Gottlob-Werner-Medal in Silver, Deutsche Mineralogische Gesellschaft.

1991 Honorary Member, Deutsche Mineralogische Gesellschaft.

1992 Silver Medal, Masaryk University Brno.

1993 Honorary Member, Mineralogical Society of Romania.

1994 Gold Medal, Comenius University Bratislava.

1995 Emanuel Bořický Medal, Charles University Prague.

1997 Corresponding Member, Croatian Academy of Sciences and Arts.

1999 Corresponding Member, Polish Academy of Arts and Sciences.

2003 Honorary President, Österreichische Mineralogische Gesellschaft.