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Harald G. Dill

The Hagendorf-Pleystein Province: the Center of Pegmatites in an Ensialic Orogen

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Dedicated to Berthold Weber (1959–2013)

Berthold was a focused man and he was more than a friend, who you cannot substitute for. As a software engineer by profession he tried to become a leading figure in his field of electronic printing, a frontrunner in his business. But never had he allowed his business to become the dominant place and absorb all his time. His personal and time management was great. He still had time enough for his fishpond, well kept and being located near Pleystein our "scientific field camp". I could not imagine to see him without a judo mat close by, either as a sportsman fighting himself or conveying his experience and knowledge to younger athletes as a trainer. In both ways, Berthold was superb and gained the highest honors. I got in contact with him,

sharing the same passion for minerals and the NE Bavarian region. The Oberpfalz was his home and my adopted country. There, he was born, raised, he was drafted to the armed forces and he began collecting minerals and practicing his sports. It was not up to him travelling across the world to pack his shelves and showcases with minerals from distant countries, he was focused on the Oberpfalz, the heartland for enthusiasts in rocks and minerals (German: Steinpfalz = Stony Palatinate).

To cooperate with him meant to have a friend at your side you can have full confidence in. Even if his desk was cramped with work and he was almost drowned with the daily routine, he did not postpone my questions. I did not receive an answer from him, he provided me with a solution. His motto was: "Carpe diem" (seize the day). He adhered to this motto even during the last months of his life when we all knew that he is going to lose this fight, even if he never gave up. But once we knew he has to leave the team forever, a few days before the last "Glückauf" at the hospital he sent me the photographs of what he called the best of Hagendorf, a series of micro mounts, accompanied by several cartoons illustrating the ideal morphology of these minerals. But he was not given time to send me the scale bar for each photograph. So I left his legacy as it stands. Those images (if some readers may find some are not of the best quality, it was my fault by making a selection too much biased by science with too little sense of mine for beauty) will keep his memory and work, alive, and bear witness that this work could not be done to completeness.

Glückauf forever!
Harald

Preface

Pegmatitic rocks are very coarse-grained rocks, generally of granitic composition; they contain as major constituents the three rock-forming minerals feldspar, quartz and mica, which in places develop mega-crystals or show up in a graphic intergrowth. On the opposite end of the grain-size scale, their little sisters are placed, finer-grained than most granites with which they share the mineralogical composition these white rocks are called aplites. Apart from the size of their crystals, be aplitic or pegmatitic, it is the varied spectrum of rare elements, e.g., Nb, Ta, Be or Li and the plethora of extraordinary minerals resultant from these elements, that draw the attention of mineralogists and mineral collectors, alike, to these felsic rocks. It has to be noted that the lion share of raw material extracted from pegmatites is feldspar, quartz and mica, and only a tiny fraction of pegmatites contains rare elements at a level so as to render mining of these rare-element pegmatites feasible. The traditional mining of pegmatitic and aplitic rocks in the Bohemian Massif, which is shared by Germany, the Czech Republic, Poland and Austria, has been focused on these industrial minerals, mainly for ceramic purposes.

There will be hardly a crustal section to match with this part of Central Europe under consideration with regard to the number, the various types and chemical and mineralogical variability of pegmatitic and aplitic rocks. In light of more than 1000 years of mining and an intensive study of the deeper parts of the basement during the recent past, using not only geological, mineralogical and geochemical methods but also all the principal techniques of deep geophysics, this region enables us to look at the origin of pegmatites in their natural habit from whatever angle you would like to do.

Hagendorf has been mined for feldspar and the deposit is not yet exhausted as far as the high-purity quartz at the core of the pegmatite is concerned. In comparison with other pegmatite deposits in the area, however, the Hagendorf-Pleystein Pegmatite Province (HPPP) is not only the largest concentration of feldspar and quartz of its kind in Central Europe but also a mineralogical treasure box with more than 250 minerals, some of which were described for the first time from this locality. It almost goes without saying that such a huge amount of minerals attracts first and foremost mineralogists who have been doing a lot of fine work, particularly at

Hagendorf-South which is second to none in the HPPP. Other geoscientific disciplines lived a bit in the shadow of mineralogy which was governed by the late Professor Strunz. Not far away from his place of birth, at Weiden he had Hagendorf-South always in his focus and as an outsider you might have come to the conclusion, that each and everything has been told about this prominent pegmatite. Professor Strunz was a generous and open-minded person, who handed over his books to young recruits like me and still left some open questions to be answered by later generations.

In the course of a renewed investigation that went way beyond mineralogy, four new occurrences (Trutzhofmühle Aploid, Pleystein New Aplite, Miesbrunn Pegmatite Aplites Swarm West and East, Reinhardsrieth Aplite) have been found and several abandoned mines and outcrops were re-sampled together with the "nigrine" placer deposits. "Nigrine", not a mineral accepted by IMA, is an intergrowth of ilmenite and rutile rife with mineral inclusions indicative of a pegmatitic source area. Taking into account these mineralogical features, these dull black heavy mineral aggregates can successfully be used as proximity indicators for pegmatitic rocks. It is a case in point where mineralogy, sedimentology and applied geomorphology worked hand in hand well together in practice. In the majority of cases geological and mineralogical results published or unpublished were combined here with an extensive examination of open-file reports and geophysical studies forming a broad and solid basis to shed some light on the economic geology of pegmatite deposits.

The current book project has been written using the term economic geology still in its traditional meaning to find new mineral deposits and enhance the exploitation of existing ones. That is why, "pegmatites and economic geology" is not used to fill an appendix at the end of the book but is placed ahead of all the other sections, even if much of it has today a historical touch. The perspectives to find new profitable mineral deposits in the region are not very promising and mining in Germany is obviously a profession of the past, but learning from nature in this part of the world may help people elsewhere in the world to be successful, or at least raise awareness of these extraordinary and still enigmatic rocks called pegmatites.

The geological evolution of the Central European Variscides is described from the geodynamic and metallogenetic point of view with the pegmatites embedded into this regional economic geology or in other words forming the centerpiece of economic geology, while often they are trailing behind VMS-, porphyry copper or epithermal mineral deposits. Finding pegmatites may open up new avenues and possibilities also for the exploration of non-pegmatitic mineral deposits, and vice versa; metallic deposits of a certain ore type can provide a clue where exploration for pegmatites is done with a chance of success. The HPPP is viewed as if looking through a magnifying glass from the small-scale overview of the economic geology of Central Europe, closely related to the various geodynamic zones, to the individual outcrops of the HPPP, and investigated during underground mapping or by means of drill core examination.

A classification scheme addressing different structural types of metapegmatites/metaaplites, pegmatoids/aploids, pegmatites/aplites, granite pegmatites and

pseudopegmatites is put forward. It is branch of the "Chessboard classification scheme of mineral deposits" and, similarly, based upon those geological and mineralogical features that experienced geologists who work nose on rock can determine in the field or in their study with the routine techniques at hand. It is a classification scheme which is open for amendments and designed for the practical use, following the tripartite subdivision in (economic) geology: describe, interpret and recommend.

The host environment of pegmatitic rocks, the ensialic orogen is the most favorable crustal section to bring about pegmatites of calc-alkaline affiliation, attractive to mineralogists and become an operational target for mining geologists. In an idealistic transect through the crust this orogen takes the central position and, given the Variscides as reference type, it is called Variscan-type in this discussion of pegmatites. On one side the Variscan type passes into the Alpine-type, where pegmatites get reworked, while on the opposite side the transect ends up in the Rift-Type where pegmatites of alkaline affiliation form.

Pegmatitic rocks in Central Europe whether they are of metamorphic or magmatic origin are not only part of a geodynamic environment but also constitute an integral part of the chronological evolution of the Variscides from the early to the late Paleozoic. Radiometric data are a key element to the understanding of pegmatites. The geochemical atlas of the F.R. of Germany, albeit not covering all rare elements of relevance for the formation of pegmatites, is supplemented by local chemical surveys so as to get a full-blown picture of the distribution pattern of rare elements on a regional scale along the western edge of the Bohemian Massif. While these chemical surveys provide information on the surface geology, seismic, gravimetric, geoelectric and magnetic surveys penetrate deeper into the crystalline basement and thereby help to reduce the field of speculation on the existence of ultra deep structures underneath the pegmatites and granites or even help to shape the various pegmatitic and aplitic bodies.

A great deal of the book is devoted to the mineralogy, considering all mineral groups present in the HPPP. In the run-up to this book, all techniques from the scanning electron microscope to the stereomicroscope were applied during mineralogical investigations, but whenever it deemed necessary, the colorful hand specimens and micro mounts were given preference over back-scattered electron images or photographs of polished sections. The latter had their merits by providing background information to establish a sequence of mineralization for the HPPP and it is prevalently their role as a marker for the physical-chemical conditions that counts when comes to the process-oriented investigation.

Large-scale mapping involving underground work on structural geology and lithology leads to a fine-tuning of the "minero-stratigraphy" and provides a clue to the pathways that were opened up for the melt and solutions and singles out the structures most favorable in terms of accommodation space for the stock-like and tabular pegmatites.

Broadly speaking, the pegmatite, aplites and granites are brothers and sisters. In the Variscides, very soon they stroke out on their own, developing their individual characteristics in terms of composition and structure so that the various lithological

processes leading to these felsic intrusive rocks can more easily be studied, each in its own compartment, than in complex pegmatites (pseudopegmatites) which are obviously the result of multi-stage emplacement and alteration processes with only the most recent of its kind preserved to the present. The notoriously raised question which granite spawned this pegmatite is a question each reader will be able to answer by himself after passing through the book.

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