An overview of the type mineralogy of Africa

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Summary

Out of the ca. 5500 valid mineral species that are currently known, about 400 have been initially described for localities in Africa. The first new mineral descriptions for this continent date from the late 18th century, but significant numbers have only been reached from the early 20th century onward. Up to now, the largest numbers of new species have been described for Namibia, the DR Congo, and South Africa, with a considerable lead over all other countries. In this overview of the type mineralogy of Africa, regional variations and the history of new mineral descriptions are covered, combined with a discussion of some general aspects of mineral species validity and mineral nomenclature, based on examples from Africa.

Samenvatting – Een overzicht van de type mineralogie van Afrika

Van de ca. 5500 geldige mineraalsoorten die momenteel gekend zijn, werden er ongeveer 400 voor het eerst beschreven voor vindplaatsen in Afrika. De eerste beschrijvingen van nieuwe mineralen voor dit continent dateren van het einde van de 18e eeuw, maar significante aantallen werden pas bereikt vanaf het begin van de 20e eeuw. Tot op heden werden de grootste aantallen nieuwe soorten beschreven voor Namibië, de DR Congo, en Zuid-Afrika, met aanzienlijke voorsprong op alle andere landen. In dit overzicht van de type mineralogie van Afrika worden regionale verschillen en de geschiedenis van de beschrijving van nieuwe mineralen overlopen, samen met een bespreking van enkele algemene aspecten van de geldigheid van mineraalsoorten en van de naamgeving van mineralen, aan de hand van voorbeelden uit Afrika.

Résumé – Un aperçu de la minéralogie type de l'Afrique

Parmi les c. 5500 espèces minérales valides qui sont connues actuellement, environ 400 ont été décrites initialement pour des endroits en Afrique. Les premières descriptions de nouvelles espèces pour ce continent datent de la fin du 18e siècle, mais des nombres significatifs n'ont été atteints qu'à partir du début du 20e siècle. Jusqu'au présent, les plus grands nombres de nouvelles espèces ont été décrits pour la Namibie, la RD Congo, et l'Afrique du Sud, avec une avance considérable sur tous les autres pays. Dans cet aperçu de la minéralogie type de l'Afrique, des variations régionales et l'historique des descriptions de nouvelles espèces minérales sont traités, en combinaison avec une discussion de quelques aspects généraux de la validité d'espèces minérales et de la nomenclature minéralogique, sur la base d'exemples africaines.

Keywords – Mineralogy; History of science; Mineral nomenclature; Africa

Introduction

The type mineralogy of a region refers to all mineral species whose original description is based on the study of specimens from that area. It is part of the natural heritage of a region, and it has important ties with the history of mineralogical research and the evolution of mineral nomenclature through time. A discussion of type mineralogy should consider both valid and non-valid mineral species, whereby ‘mineral species’ refers to crystalline substances that formed by natural geological processes and that are characterized by a unique crystal structure and a well-defined chemical composition. Valid species are in practice those which have been approved at some stage by the Commission on New Minerals, Nomenclature and Classification (CNMNC) of the International Mineralogical Association (IMA), founded in 1959.

A discussion of the type mineralogy of most continents is a vast subject. For Africa, a complete overview of all valid and non-valid species by country, with a fully referenced presentation of the history of the description of each species, has recently become available (MEES 2018). The present text is limited to a general historical overview and to some comments about selected aspects of mineral nomenclature, illustrated by African examples.

Overview

At this moment (January 2020), a total of 5532 valid mineral species, with type locality on any continent, are known, based on the most recent edition of the list that is published periodically by the IMA-CNMNC (November 2019). Among those species, 409 were first described, entirely or in part, for specimens from African localities. This number is relatively small in comparison with those for other continents, such as Europe and North America, where the study of mineral occurrences had a much earlier start.

The repartition within Africa shows strong variations between countries (Table 1). New mineral species have been described for 29 African countries, on a total of 54. Three nations have together provided nearly three quarters of all African species, namely Namibia, the DR Congo, and South Africa. For a few other countries the total also exceeds ten, but for most other listed countries only one or two new species have been described. The total of all valid species enumerated in Table 1 is 411, which is greater than the real total of 409, due to two species with shared type localities in two African countries (gallite, described for both Namibia and the DR Congo, and palladosilicide, described for both South Africa and Tanzania). The total of 409 species can be increased by also considering type localities on islands that are part of the African continent but that currently belong to non-African nations. This concerns three minerals, described for Gran Canaria (mogánite), Socotra (riebeckite), and Ascension (dalyite). In addition, the total could be more significantly enlarged by attributing minerals described for meteorites to the country where the meteoritic type material was found, as arguably done in some form by the IMA-CNMNC. For meteorites collected in Africa, 14 valid new species have been described up to now, including eight for meteorites found in Morocco.

As non-valid species, a total of 152 minerals can be proposed for Africa, varying in degree of formality of their original description and in type of discreditation. Among the three nations for which most valid new species have been described, South Africa has the lowest ratio of valid to non-valid species (Table 1), due to descriptions of named compounds belonging to categories such as types of asbestos and impure diamond. The record is also poor for countries like Madagascar (including nine minerals described by Alfred Lacroix between 1910 and 1923) and Tanzania (including six gemstone types representing mineral varieties). For other countries, the record is much better, both for countries where a single deposit was intensively investigated during a short period of time (*e.g.* Gabon) and for countries yielding new mineral species for various localities over longer periods (*e.g.* Morocco).

New mineral descriptions for Africa through time

Naming of minerals has a long tradition, going back to classical antiquity. Ancient written sources include works by Theophrastus (*Περì Λιθων*, ca. 300 BCE), Dioscorides (*De Materia Medica*, ca. 50-70 CE), and Pliny the Elder (*Naturalis Historia*, ca. 77 CE), which are all widely accessible through annotated translations. For minerals described in these texts, and in more recent important works such as *De Re Metallica* by Georgius Agricola (ca. 1556), only a few have some connection with Africa. One example is natron, for which Egypt is listed in early texts as one of the known localities. This may well refer to salt lakes of the Wadi Natrun depression, West of the Nile River delta, but natron in the sense of Pliny and others was clearly a general term for sodium carbonate deposits, without corresponding to the mineral as it was subsequently defined (natron, $Na_2(CO_3).10H_2O$). Another example is topaz ($Al_2SiO_4F_2$), whose name is derived from Topazion (Zabargad), an island along the coast of Egypt, but it almost certainly originally referred to forsterite ($Mg_2(SiO_4)$), for which the island is a known locality. The most convincing example is in fact emerald, for which Wadi Sikait in the Eastern Desert of Egypt is assumed to have been the original source, but this only concerns a beryl ($Be_3Al_2Si_6O_{18}$) variety, not a valid species.

The oldest modern description of a new mineral species for a locality in Africa has been widely considered to be that of prehnite, recognized for an unspecified locality in the former Cape Province (Table 2). It was first described by KLAPROTH (1788), who refers for the name to the classification system of Abraham Werner, which is best known through a report with a later publication date than the article by Klaproth (HOFFMANN 1789). Together with witherite and torbernite, prehnite was the first mineral whose name was derived from that of a person (Hendrik Prehn or von Prehn, an army officer who provided the type material). At the time of publication, this attracted strong criticism from some mineralogists, who argued that names referring to persons are intrinsically meaningless, containing no information about the nature of the mineral.

The status of prehnite as first African mineral is in fact unjustified, because its description was preceded by that of trona by BAGGE (1773), for a locality whose rather vague identification does allow an attribution to present-day Libya (‘Suckena Province, two days journey from Fezzan’) (Table 2).

Prehnite and trona were the only new mineral species described for Africa in the course of the 18th century. During the 19th century, only six new mineral species were added

(Table 2), which is a very small number in comparison with what was reported for other parts of the world in the same period. They include two ammonium minerals discovered for guano deposits along the coast of southern Africa that were surveyed at that time as a source of fertilizer (stercorite, teschemacherite), one salt efflorescence mineral described for an (ephemeral) occurrence in South Africa (apjohnite), two antimony minerals from historical mining sites in northern Algeria (nadorite, senarmontite), and a metamorphic mineral with type locality on the island of Socotra (riebeckite). The latter is probably the most widely known mineral with African roots, at least among geologists.

The rate of recognition of new species became greater from the start of the 20th century onward, with a steady increase up to the 1980s (Fig. 1). During the first two decades, half of all new African species were described by Alfred Lacroix of the *Muséum National d'Histoire Naturelle* in Paris, for specimens collected in erstwhile French colonies (Table 2). Other examples are the first two new minerals from Tsumeb in Namibia, a deposit for which a great number of new species has subsequently been identified. They also include a first uranium mineral (rutherfordine), described for a locality in Tanzania rather than for the DR Congo, as well as two zinc minerals from the Zambian part of the Copperbelt region of Central Africa (parahopeite, tarbuttite), predating the description of the first new species for the Katangese part (cornetite). For both categories of minerals, *i.e.* secondary minerals containing uranium or locally abundant base metals, Katanga has later been a much more important type locality area than any neighbouring region.

The increase in number of valid new species described through time for Africa between the 1900s and the 1980s was followed by two less productive decades, followed by a new increase. These overall trends are compatible with patterns that are recognized when all new species, for all continents, are considered (BARTON 2019), described mainly in terms of peak periods (1960s, 1980s, 2010s). Important factors are technological improvements, including development of new analytical methods, but also the transition from analogue to digital registration of measurements, the creation of databases with reference data, and an evolution towards wider access to those data sets. The impact of new analytical methods is illustrated by some new mineral descriptions for African localities: in the 1930s, braggite (PtS) was presented as the first species to have been recognized by X-ray diffraction analysis and named in honour of the developers of the method (BANNISTER & HEY 1932), and in the 1960s, a pioneering microprobe study lead to the description of geversite ($PtSb_2$; STUMPFL 1961), together with the first characterization of some unnamed compounds that were later defined as valid new species (*e.g.* genkinite, stumpflite).

Mineral species validity

The preceding section mainly dealt with valid mineral species. As mentioned in the beginning, specimen validity is currently decided by an international commission (IMA-CNMNC). Before the establishment of this screening system in 1959, one important form of evaluation of new mineral descriptions and subsequent studies consisted of the opinion presented in authoritative handbooks. The most influential has been Dana's *System of Mineralogy*, especially the first six editions, published between 1837 and 1892. At that time, it was relatively common for authors of handbooks to propose names for assumedly valid minerals that had been described by others as unnamed species, which has later been unsuccessful (*e.g.* POVARENNYKH 1972) or widely criticized (GAGARIN & CUOMO 1949). Some of the earliest minerals described as new species for African localities were in fact named by others (see Table 2): senarmontite and teschemacherite by J.D. Dana, apjohnite by E.F. Glocker, and cornetite by H. Buttgenbach. Another form of evaluation consisted of reviews of new mineral descriptions in mineralogical journals. The most systematic and influential reviews have been those in *American Mineralogist*, founded in 1916. The assessments presented in these compilations were generally well justified, but they do record to some extent the opinion of individual mineralogists, including long-serving editors such as Michael Fleischer, which always introduces the risks of a certain degree of bias, for example in accepting proposals for discreditation by others, as in the case of e.g. epiianthinite and partridgeite. On occasion, the style in which new mineral names were rejected was rather harsh, as in the case of borgniezite, for which Fleischer stated that 'there is no excuse for burdening the literature with such names'.

Since the creation of the IMA-CNMNC, this commission evaluates all new mineral proposals. The first round of voting still dealt exclusively with minerals whose description had already been published, with delhayelite, pandaite (later discredited), wyartite, and yoderite as approved African species, and with epiianthinite, dixeyite, and kivuite as discredited species. In this first report (ANON. 1962), the commission insisted again that new mineral proposals should in future be submitted before publication, a practice that is now widely respected. Among minerals described for African localities, congolite (WENDLING *et al.* 1972) is an example of a more recently described mineral that was only approved after publication, and arnhemite and pyrophosphite (MARTINI 1994) are examples of non-valid species whose descriptions were published despite their rejection by the IMA-CNMNC, in both cases with publication in non-mineralogical journals.

In addition to evaluating individual new mineral proposals, the IMA-CNMNC has also published general nomenclature reports presenting decisions for large numbers of species (*e.g.* NICKEL & MANDARINO 1987; BURKE 2006), as well as reports dealing with specific mineral groups (*e.g.* HENRY et al., 2011; HAWTHORNE et al. 2012), both containing many decisions affecting the status of minerals described for African localities. One example of an African mineral whose status has changed through time is hydropyrochlore $((H_2O,\square)_2Nb_2(O,OH)_6(H_2O))$, which was originally described as an unnamed pyrochlore variety by VAN WAMBEKE (1965), who explicitly referred to a need for IMA-CNMNC consensus on pyrochlore group nomenclature before a name could be proposed. This was later done by describing it as kalipyrochlore in an IMA-approved nomenclature report by HOGARTH (1977), followed by a full description under that name by VAN WAMBEKE (1978), but the mineral currently qualifies as hydropyrochlore in the revised pyrochlore classification system presented by ATENCIO *et al.* (2010). The complexity of changes in mineral nomenclature is also illustrated by tweddillite ($CaSr(Mn^{3+}{}_2Al)[Si_2O_7][SiO_4]O(OH)$), described as a new mineral by ARMBRUSTER *et al.* (2002). A short time later, the name was replaced by manganipiemontite-(Sr), at the introduction of a root-name-based nomenclature system for the epidote group, presented in an IMA report with the same first author as the tweddillite description (ARMBRUSTER *et al.* 2006). The name was later reinstated, arguing that it had been too widely used to be suppressed (REVHEIM & KING 2016). Both examples concern mineral groups characterized by a continuous wide range in composition between various end-members, for which nomenclature rules expressing element-dominance at specific crystal lattice sites are generally imposed, in order to obtain a limited number of rational names, including names for species that have not yet been discovered or formally described. A related example are minerals containing rare-earth elements (REE) as essential constituents, for which the rules proposed by LEVINSON (1966) have been adopted by the IMA-CNMNC, with a suffix recording the dominant REE and with preservation of the name of the first described species if it exists, even if part of the root name is redundant (yttrocolumbite-(Y)) or contradictory (yttrotungstite-(Ce)).

Mineral names

Despite arguments against mineral names referring to persons in the largely prehnite-centred debate that took place at the end of the 18th century, naming minerals in honour of individuals has since become common practice. Out of the 409 species described for type localities in Africa, a majority has been named after persons (231 species; Table 3). The other main categories are mineral names referring to provenance (78 species) and to chemical or physical characteristics (30 species). In addition, many mineral names are derived from those of existing species (62 species), typically with a prefix or suffix specifying the nature of the difference between the new and earlier defined species. The few names that can not be assigned to these categories include some referring to organisations (*e.g.* nimite, sasaite) or to deposit type (*e.g.* stercorite), as well as one name derived from that of a journal (minrecordite) (Table 4).

Most persons in whose honour minerals have been named are mineralogists or geologists. The latter include many who have worked for mining companies, which are also represented by various other types of professions, including prospectors, administrators, and mine owners. Physicists and chemists include several pioneers in the study of radioactivity, in whose honour uraniumbearing minerals have been named (*e.g.* becquerelite, curite, rutherfordine). A recent trend is naming minerals after mineral collectors and dealers, for regions currently producing collectable specimens. The total of 231 valid mineral species named after persons does not correspond to the number of individuals involved, because a few have been named after more than one person (braggite, ludlockite, taniajacoite), compensated by two mineral names referring (in part) to the same person (keyite, ludlockite). A few more examples of double use of person names exist when both valid and non-valid species are considered (hermannroseite/roseite, sidpietersite/pietersite). Among the 231 valid species, only ten have been named after women (clairite, effenbergerite, erikapohlite, eylettersite, giniite, joosteite, kudryavtsevaite, mathiasite, sklodowskite, tredouxite), which includes three minerals named in tribute of the wife of the author of the mineral's description. Another observation is that only a single African mineral species has been named in honour of a non-Caucasian African national (nyerereite).

As illustrated by some of the mentioned examples, most names referring to persons are based on family names or on a combination of given names and family names. Others have been derived in a more complex manner, such as afwillite (A.F. Williams), orlymanite (Orlando Lyman), and warikahnite (Walter Richard Kahn), which is another practice that has been criticized at some stage (EAKLE 1928). Also mélonjosephite, named in honour of Joseph Mélon, could well have been named more intuitively by respecting the normal order of name and surname.

Names referring to provenance mainly concern mining sites or other specific localities, but several names refer to regions (*e.g.* shabaite-(Nd)) or to the country of origin as a whole (congolite, kenyaite, marokite, senegalite, tunisite, zaïrite, zimbabweite). The current ferronigerite-2*N*1*S*, originally described as nigerite, could be seen as another example, but not namibite, named after the Namib Desert. The type locality of namibite is in fact at some distance from that region. Other examples of somewhat misleading names are atokite and rustenburgite, named after mines that are not specified as type locality in the original description.

Names based on mineral properties include those referring to composition, which can be limited to a single major element (*e.g.* gallite, germanite) or provide more complete information (*e.g.* althupite, bismoclite). Physical properties recorded by mineral names include colour (*e.g.* ianthinite), crystal morphology (*e.g.* triangulite), and aggregate type (*e.g.* oursinite).

Numbers for all categories of mineral names are increased if derived names would not be considered separately. They include names referring to a difference in dominant metallic element (*e.g.* zincobriartite), dominant anion group (*e.g.* arsenohopeite), dominant rare-earth element (*e.g.* allanite-(Y)), water content (*e.g.* metavanmeersscheite), or crystal structure (*e.g.* trikalsilite). Other derived names were coined as part of root-name-based systems (*e.g.* hydrokenopyrochlore, potassic-fluoro-pargasite, ferronigerite-2*N*1*S*). Still others express a genetic relationship, such as formation through dehydration (*e.g.* metaschoepite), or a relationship based on shared mineral properties (maghemite).

Differences between countries

Between African countries, great differences exist in the number of new mineral species that have been described (see Table 1). One aspect is simply the size of a country, whereby Gambia intrinsically has smaller potential than Zambia, but it is clearly not the only factor. For example, the three most productive countries (Namibia, DR Congo, South Africa) are all quite large, but several other sizeable countries have not yielded any new mineral species (*e.g.* Angola, Mali, Sudan). A more important factor is regional geological setting and the occurrence of mineral deposits with unique characteristics. An overview of the localities for which most new mineral species have been recognized shows that exceptional deposits are responsible for a large proportion of those species (Table 5). For Namibia, about two thirds of all new species have been described for Tsumeb, with the Kombat mine as a distant but important second. For the DR Congo, more than a third of all new species has the historically important uranium deposit of Shinkolobwe as type locality. For South Africa, the Kalahari Manganese Field, comprising the Wessels and N’Chwaning mines, are responsible for a third of all valid species, and a significant number has been described for various Bushveld Complex localities. Other major African sites or areas are the Bou-Azzer district and Tachgagalt in Morocco, as well as Mounana in Gabon, the latter producing all nine minerals described as new species for that country.

Besides the presence of unique deposits, the history of their discovery, mining, and mineralogical study has also been a major factor. Great economic or strategic interest in specific commodities during certain periods has for example prompted mineralogical research for Bushveld Complex deposits, and it has at least made specimens from deposits such as Shinkolobwe widely available at some stage. Several series of new minerals have been identified through the efforts of individual mineralogists or groups of researchers. Some of the previously mentioned important deposits, such as Mounana and Tachgagalt (Table 5), count as examples of this. It is also clearly expressed by peaks in the histogram presenting the evolution of new mineral discoveries through time for the DR Congo (Fig. 2), with maxima reflecting the work of Alfred Schoep (1920s), Johannes Vaes (1940s), Thure Sahama (1950s) and Michel Deliens in collaboration with Paul Piret (1980s).

Finally, a kind of self-reinforcement seems to exist, whereby specimens from localities with an established reputation of in terms of new mineral potential are most likely to be studied with great attention by collectors and mineralogists.

Concluding remarks

In closing, a discussion of the type mineralogy of Africa on a forum provided by the Royal Academy for Overseas Sciences is an opportunity to highlight the connections that exist between this Academy and new mineral descriptions for Africa. Most importantly, several new species have been described for specimens from Africa by members of the Academy. The most productive member has been Michel Deliens, who was involved in the description of 28 valid new species, which at this moment is still the greatest number to have been reached for Africa by any researcher. Other Academy members who have contributed in this way to the type mineralogy of Africa are Henri Buttgenbach and Jacques Thoreau. These two mineralogists are also among the fourteen Academy members in whose honour African mineral species have been named, including two non-valid species (Table 6). In publications of the Academy, the original description of three new species has appeared, namely those of sharpite (MÉLON, 1938), varlamoffite (GASTELLIER, 1950), and lueshite (SAFIANNIKOFF, 1959), and. For varlamoffite, an earlier mention by BUTTGENBACH (1947, p. 182-183) exists, but the Academy publication by GASTELLIER (1950) is a reproduction of an unpublished note by the same author that dates from 1946. Finally, a lasting contribution to the type mineralogy of Africa in a publication by the Academy has been the first use of the concept and name of 'columbo-tantalite' by LANCSWEERT (1954), a term that has subsequently, in abbreviated form (coltan), become widely known, also outside the fields of mineralogy and geology, as the informal name of one of the main mineral resources of the Great Lakes region of Central Africa.

References

ANON. 1962. International Mineralogical Association: Commission on New Minerals and Mineral Names. – *Mineralogical Magazine*, **33**: 260-263.

ARMBRUSTER, T., GNOS, E., DIXON, R., GUTZMER, J., HEJNYS, C., DÖBELIN, N. & MEDENBACH, O. 2002. Manganvesuvianite and tweddillite, two new Mn^{3+}-silicate minerals from the Kalahari manganese fields, South Africa. – *Mineralogical Magazine*, **66**: 137-150.

ARMBRUSTER, T., BONAZZI, P., AKASAKA, M., BERMANEC, V., CHOPIN, C., GIERE, R., HUESS-ASSBICHLER, S., LIEBSCHER, A., MENCHETTI, S., PAN, Y. & PASERO, M. 2006. Recommended nomenclature of epidote-group minerals. – *European Journal of Mineralogy*, **18**: 551-567.

ATENCIO, D., ANDRADE, M.B., CHRISTY, A.G., GIERÉ, R. & KARTASHOV, P.M. 2010. The pyrochlore supergroup of minerals: nomenclature. – *Canadian Mineralogist*, **48**: 673-698.

BAGGE, C. 1773. Om trona, eller ett slags natron, som finnes i Konungariket Tripoli i Barbariet. – *Kongliga Vetenskaps Academiens Handlingar*, **34**: 140-143.

BANNISTER, F.A. & HEY, M.H. 1932. Determination of minerals in platinum concentrates from the Transvaal by X-ray methods. – *Mineralogical Magazine*, **23**: 188-206.

BARTON, I.F. 2019. Trends in the discovery of new minerals over the last century. – *American Mineralogist*, **104**: 641-651.

BURKE, E.A.J. 2006. A mass discreditation of GQN minerals. – *Canadian Mineralogist*, **44**: 1557-1560.

BUTTGENBACH, H. 1947. Les Minéraux de Belgique et du Congo belge. – Paris, Dunod, 573 pp.

EAKLE, A.S. 1928. Mineral names. – *American Mineralogist*, **13**: 533-536.

GAGARIN, G. & CUOMO, J.R. 1949. Algunas Proposiciones sobre Nomenclatura Mineralogica. – *Comunicaciones del Instituto Nacional de Investigacion de las Ciencias Naturales, Museo Argentino de Ciencias Naturales Bernardino Rivadavia, Ciencias Geologicas*, **1** (5): 21 pp.

GASTELLIER, S. 1950. Note sur un minéral jaune trouvé par M. Varlamoff. – *Bulletin des Séances de l'Institut Royal Colonial Belge*, **21**: 412-419.

HAWTHORNE, F.C., OBERTI, R., HARLOW, G.E., MARESCH, W.V., MARTIN, R.F., SCHUMACHER, J.C. & WELCH, M.D. 2012. Nomenclature of the amphibole supergroup. – *American Mineralogist*, **97**: 2031-2048.

HENRY, D.J., NOVAK, M., HAWTHORNE, F.C., ERTL, A., DUTROW, B.L., UHER, P. & PEZZOTTA, F. 2011. Nomenclature of the tourmaline-supergroup minerals. – *American Mineralogist*, **96**: 895-913.

HOFFMANN, C.A.S. 1789. Mineralsystem des Herrn Inspektor Werners mit dessen Erlaubnis herausgegeben von C.A.S. Hoffmann. – *Bergmännisches Journal*, **1**: 369-398.

HOGARTH, D.D. 1977. Classification and nomenclature of the pyrochlore group. – *American Mineralogist*, **62**: 403-410.

KLAPROTH, M.H. 1788. Chemische Zergliederung des Prehnits. – *Schriften der Berlinischen Gesellschaft Naturforschender Freunde*, **8**: 211-223.

LANCSWEERT, P. 1954. Note sur les columbo-tantalites du Maniema. – *Bulletin des Séances de l'Institut Royal Colonial Belge*, **25**: 464-475.

LEVINSON, A.A. 1966. A system of nomenclature for rare-earth minerals. – *American Mineralogist*, **51**: 152-158.

MARTINI, J.E.J. 1994. Two new minerals originated from bat guano combustion in Arnhem Cave, Namibia. – *Bulletin of the South African Speleological Association*, **33**: 66-69.

MEES, F. 2018. The Type Mineralogy of Africa. – *Tervuren African Geoscience Collection*, **110**: 648 pp.

MÉLON, J. 1938. La sharpite, nouveau carbonate d'uranyle du Congo belge. – *Bulletin des Séances de l'Institut Royal Colonial Belge*, **9**: 333-336.

NICKEL, E.H. & MANDARINO, J.A. 1987. Procedures involving the IMA Commission on New Minerals and Mineral Names and guidelines on mineral nomenclature. – *American Mineralogist*, **72**: 1031-1042.

POVARENNYKH, A.S. 1972. Crystal Chemical Classification of Minerals. – New York, Plenum Press, 766 pp.

REVHEIM, O. & KING, V.T. 2016. Epidote supergroup nomenclature: the names hancockite, niigataite and tweddillite reinstated. – *Mineralogical Magazine*, **80**: 877-880.

SAFIANNIKOFF, A. 1959. Un nouveau minéral de niobium. – *Bulletin des Séances de l'Académie royale des Sciences d'Outre-Mer*, **5**: 1251-1255.

STUMPFL, E.F. 1961. Some new platinoid-rich minerals, identified with the electron microanalyser. – *Mineralogical Magazine*, **32**: 833-847.

VAN WAMBEKE, L. 1965. A Study of Some Niobium-bearing Minerals of the Lueshe Carbonatite Deposit (Kivu, Rep. of Congo). – Euratom Report 2110e, 31 pp.

VAN WAMBEKE, L. 1978. Kalipyrochlore, a new mineral of the pyrochlore group. – *American Mineralogist*, **63**: 528-530.

WENDLING, E., HODENBERG, R.V. & KÜHN, R. 1972. Congolit, der trigonale Eisenboracit. – *Kali und Steinsalz*, **6**: 1-3.

Table1. Number of valid and non-valid mineral species with type locality in an African country, arranged according to number of valid species.

Country	Valid	Non-valid	Country	Valid	Non-valid
Namibia	107	21	Lesotho	2	0
DR Congo	100	27	Mozambique	2	5
South Africa	79	37	Nigeria	2	0
Morocco	21	3	Tunisia	2	2
Madagascar	17	11	Burundi	1	0
Tanzania	14	11	Chad	1	1
Gabon	9	0	Egypt	1	5
Kenya	8	3	Ethiopia	1	2
Zambia	8	1	Ghana	1	0
Algeria	6	6	Libya	1	1
Uganda	6	2	Niger	1	1
Rwanda	5	0	Senegal	1	1
Guinea	4	3	Angola	0	1
Botswana	3	0	Cabo Verde	0	1
R. Congo	3	0	Sierra Leone	0	1
Zimbabwe	3	4	Sudan	0	1
Cameroon	2	0	Swaziland	0	1

Table 2. The first minerals described as new species for localities in Africa, arranged chronologically, up to 1919.

Name	Formula	Publication	Locality	Country
18th century				
trona	$Na_3(HCO_3)(CO_3).2H_2O$	Bagge (1773)	Suckena Province	Libya
prehnite	$Ca_2Al(Si_3Al)O_{10}(OH)_2$	Klaproth (1788)	Cape Province	South Africa
19th century				
teschemacherite	$(NH_4)H(CO_3)$	Teschemacher (1845)	coastal site	South Africa
apjohnite	$Mn^{2+}Al_2(SO_4)_4.22H_2O$	Glocker (1847)	Algoa Bay	South Africa
stercorite	$(NH_4)Na(PO_3OH).4H_2O$	Herapath (1850)	Ichaboe Island	Namibia
senarmontite	Sb_2O_3	de Senarmont (1851)	Sensa	Algeria
nadorite	$PbSb^{3+}O_2Cl$	Flajolot (1870)	Djebel Nador	Algeria
riebeckite	$\square Na_2(Fe^{2+}_3Fe^{3+}_2)Si_8O_{22}(OH)_2$	Sauer (1888)	Socotra	Yemen
20th century, first decade				
grandidierite	$MgAl_3O_2(BO_3)(SiO_4)$	Lacroix (1902)	Andrahomana	Madagascar
otavite	$Cd(CO_3)$	Schneider (1906)	Tsumeb	Namibia
rutherfordine	$(UO_2)(CO_3)$	Marckwald (1906)	Lukwengule	Tanzania
bityite	$CaLiAl_2(Si_2BeAl)O_{10}(OH)_2$	Lacroix (1908)	Mont Bity	Madagascar
plancheite	$Cu_8(Si_4O_{11})_2(OH)_4.H_2O$	Lacroix (1908)	Mindouli	R Congo
villiaumite	NaF	Lacroix (1908)	Rouma Island	Guinea
parahopeite	$Zn_3(PO_4)_2.4H_2O$	Spencer (1908)	Kabwe	Zambia
tarbuttite	$Zn_2(PO_4)(OH)$	Spencer (1908)	Kabwe	Zambia
20th century, second decade				
cornetite	$Cu_3(PO_4)(OH)_3$	Cesàro (1912)	Etoile Mine	DR Congo
manandonite	$Li_2Al_4(Si_2AlB)O_{10}(OH)_8$	Lacroix (1912)	Antandrokomby	Madagascar
tsumebite	$Pb_2Cu(PO_4)(SO_4)(OH)$	Busz (1912)	Tsumeb	Namibia
fornacite	$CuPb_2(CrO_4)(AsO_4)(OH)$	Lacroix (1915)	Renéville	R Congo

Table 3. Categories of names for minerals with type locality in Africa.

Category	Total	Namibia	DR Congo	South Africa
Persons	**231**	**65**	**61**	**45**
mineralogists	82	28	17	14
geologists	71	4	30	16
collectors, dealers	29	19	1	7
mining company staff	22	11	5	3
physicists, chemists	9	0	5	2
government and army staff	6	0	0	1
others	12	3	3	2
Locality	**78**	**18**	**15**	**14**
locality	62	13	13	13
region	9	5	1	1
country	7	0	1	0
Properties	**30**	**4**	**12**	**8**
composition	24	4	7	7
morphology, colour	6	0	5	1
Derived names	**62**	**16**	**12**	**10**
Other categories	**8**	**4**	**0**	**2**

Table 4. Information about the etymology of minerals mentioned in the text.

Name [1]	Formula	Locality [2]	Etymology
afwillite	$Ca_3[SiO_4][SiO_2(OH)_2].2H_2O$	Dutoitspan Mine, SA	Alpheus F. Williams
allanite-(Y)	$CaY(Al_2Fe^{2+})[Si_2O_7][SiO_4]O(OH)$	Zaaiplaats Mine, SA	Y-dominant allanite
althupite	$AlTh(UO_2)_7(PO_4)_4O_2(OH)_5.15H_2O$	Kobokobo, DRC	Al-Th-U-P mineral
arsenohopeite	$Zn_3(AsO_4)_2.4H_2O$	Tsumeb, NM	arsenate analogue of hopeite
atokite	Pd_3Sn	Bushveld Igneous Complex, SA	Atok Mine
becquerelite	$Ca(UO_2)_6O_4(OH)_6.8H_2O$	Shinkolobwe, DRC	A.Henri Becquerel
bismoclite	$BiOCl$	Jackals Water, SA	Bi-O-Cl mineral
braggite	PtS	Bushveld Igneous Complex, SA	W.H. Bragg & W.L. Bragg
clairite	$(NH_4)_2Fe^{3+}_3(SO_4)_4(OH)_3.3H_2O$	Lone Creek Fall cave, SA	Claire Zingg-Martini
curite	$Pb_{3+x}[(UO_2)_4O_{4+x}(OH)_{3-x}]_2.2H_2O$	Shinkolobwe, DRC	Pierre Curie
effenbergerite	$BaCuSi_4O_{10}$	Wessels Mine, SA	Herta S. Effenberger
erikapohlite	$Cu^{2+}_3(Zn,Cu,Mg)_4Ca_2(AsO_4)_6.2H_2O$	Tsumeb, NM	Erika Pohl-Ströher
eylettersite	$Th_{0.75}Al_3(PO_4)_2(OH)_6$	Kobokobo, DRC	Lea Eyletters
ferronigerite-2*N*1*S*	$(Al,Fe,Zn)_2(Al,Sn)_6O_{11}(OH)$	Egbe, NG	nigerite polysome
gallite	$CuGaS_2$	Kipushi (DRC), Tsumeb (NM)	gallium-bearing minera
germanite	$Cu_{13}Fe_2Ge_2S_{16}$	Tsumeb, NM	germanium-bearing mineral
giniite	$Fe^{2+}Fe^{3+}_4(PO_4)_4(OH)_2.2H_2O$	Usakos, NM	Gini Keller
hermannroseite	$CaCu(PO_4)(OH)$	Tsumeb, NM	Hermann Rose
hydrokenopyrochlore	$\square^2Nb^2O^4(OH)^2(H^2O)$	Antandrokomby, MD	pyrochlore with dominant H_2O and vacancy
ianthinite	$U^{4+}_2(UO_2)_4O_6(OH)_4.9H_2O$	Shinkolobwe , DRC	violet colour (*ianthinos* in Greek)
joosteite	$Mn^{2+}Mn^{3+}O(PO_4)$	Helikon II Mine, NM	Charlotte Jooste
kudryavtsevaite	$Na_3MgFe^{3+}Ti_4O_{12}$	Orapa, BT	Galina Kudryavtseva
keyite	$Cu^{2+}_3Zn_4Cd_2(AsO_4)_6.2H_2O$	Tsumeb, NM	Charles Locke Key
ludlockite	$PbFe^{3+}_4As^{3+}_{10}O_{22}$	Tsumeb, NM	F. Ludlow Smith & C. Locke Key
maghemite	$(Fe^{3+}_{0.67}\square_{0.33})Fe^{3+}_2O_4$	Bushveld Igneous Complex, SA	combined magnetite and hematite properties
mathiasite	$(K,Ba,Sr)(Zr,Fe)(Mg,Fe)_2(Ti,Cr,Fe)_{18}O_{38}$	Jagersfontein, Bultfontein, SA	Morna Mathias
mélonjosephite	$CaFe^{2+}Fe^{3+}(PO_4)_2(OH)$	Angarf-Sud, MR	Joseph Mélon
metaschoepite	$(UO_2)_8O_2(OH)_{12}.10H_2O$	Shinkolobwe, DRC	schoepite dehydration product
metavanmeersscheite	$U(UO_2)_3(PO_4)_2(OH)_6.2H_2O$	Kobokobo, DRC	dehydrated vanmeersscheite
minrecordite	$CaZn(CO_3)_2$	Tsumeb, NM	Mineralogical Record
namibite	$Cu(BiO)_2(VO_4)(OH)$	Khorixas, NM	Namib Desert
nimite	$(Ni,Mg,Al)_6(Si,Al)_4O_{10}(OH)_8$	Bon Accord, SA	National Institute for Metallurgy (NIM)
nyerereite	$Na_2Ca(CO_3)_2$	Oldoinyo Lengai, TZ	Julius K. Nyerere
orlymanite	$Ca_4Mn^{2+}_3Si_8O_{20}(OH)_6.2H_2O$	Wessels Mine, SA	Orlando H. Lyman
oursinite	$Co(UO_2)_2(SiO_3OH)_2.6H_2O$	Shinkolobwe, DRC	radial aggregates (sea urchin)
potassic-fluoro-pargasite	$KCa_2(Mg_4Al)Si_6Al_2O_{22}F_2$	Tranomaro area, MD	pargasite with dominant K and F
pietersite *	$\square Na_2(Fe^{2+}_3Fe^{3+}_2)Si_8O_{22}(OH)_2$	Outjo, NM	Sidney Pieters
roseite *	Os-Ir sulfide	Yubdo, ETH	Hermann Rose
rustenburgite	Pt_3Sn	Bushveld Igneous Complex, SA	Rustenburg Mine
rutherfordine	$(UO_2)(CO_3)$	Lukwengule, TZ	Ernest Rutherford
sasaite	$Al_6(PO_4)_5(OH)_3.36H_2O$	West Driefontein cave, SA	South African Speleological Association
shabaite-(Nd)	$CaNd_2(UO_2)(CO_3)_4(OH)_2.6H_2O$	Kamoto, DRC	Shaba
sidpietersite	$Pb^{2+}_4(S_2O_3)O_2(OH)$	Tsumeb, NM	Sidney Pieters
sklodowskite	$Mg(UO_2)_2(SiO_3OH)_2.6H_2O$	Shinkolobwe, DRC	Maria Sklodowska (Marie Curie)
stercorite	$(NH_4)Na(PO_3OH).4H_2O$	Ichaboe Island, NM	guano deposit (*stercoro*, Latin for manuring)
taniajacoite	$SrCaMn^{3+}_2Si_4O_{11}(OH)_4.2H_2O$	N'Chwaning III Mine, SA	Tania & Jaco Janse van Nieuwenhuizen
tredouxite	$NiSb_2O_6$	Bon Accord, SA	Marian Tredoux
trikalsilite	$K_3NaAl_3(SiO_4)_3$	Nyiragongo area, DRC	structural relationship with kalsilite
triangulite	$Al_3(UO_2)_4(PO_4)_4(OH)_5.5H_2O$	Kobokobo, DRC	trinagular shape
warikahnite	$Zn_3(AsO_4)_2.2H_2O$	Tsumeb, NM	Walter Richard Kahn
zincobriartite	$Cu_2(Zn,Fe)(Ge,Ga)S_4$	Kipushi, DRC	zinc-dominant briartite

[1] * non-valid minerals

[2] BT Botswana, DRC DR Congo, ETH Ethiopia, MD Madagascar, MR Morocco, NM Namibia, SA South Africa, TZ Tanzania

Table 5. Individual and grouped localities for which the greatest numbers of new species have been described.

Category	#	South Africa
Namibia (Σ 107)		
Tsumeb	72	sulfide ore body, with subsurface oxidation zones
Kombat	16	sulfide ore body, in dolomite host rock
Aris	6	phonolite
DR Congo (Σ 100)		
Shinkolobwe	39	vein-type uranium deposit
Kobokobo	13	uraniumbearing, phosphate-rich pegmatite
Musonoi	6	U-Se-rich ore body within stratiform Cu-Co deposits
Nyiragongo volcano	6	melilite-nephelinite lava
South Africa (Σ 79)		
Kalahari Manganese Field	25	hydrothermally altered sedimentary Mn deposits
Bushveld Complex	15	platinum-group element deposits
Bon Accord	7	mantle-derived Ni ore deposit
Morrocco (Σ 21)		
Bou-Azzer mining district	8	oxidation zone of hydrothermal Co-arsenide ore deposit
Tachgagalt	7	vein-type manganese ore deposit
Gabon (Σ 9)		
Mounana	9	sandstone-hosted uranium deposit

Table 6. Academy members in whose honour mineral species have been named.

Name	Profession and affiliation	Mineral
Raymond Anthoine (1888-1971)	mining engineer, various companies	anthoinite
Henri Buttgenbach (1874-1964)	mineralogist, Université de Liège	buttgenbachite
Félicien Cattier (1869-1946)	administrator, Union Minière du Haut-Katanga	cattierite
Jules Cornet (1865-1929)	geologist, Ecole des Mines de Mons	cornetite
Fernand Delhaye (1880-1946)	geologist, various companies	delhayelite
Hubert Droogmans (1858-1938)	administrator, Comité Spécial du Katanga	droogmansite *
Paul Fourmarier (1877-1970)	geologist, Université de Liège	fourmarierite
Armand François (1922-2012)	geologist, Union Minière du Haut-Katanga, GCM	françoisite-(Nd)
Jacques Lepersonne (1909-1997)	geologist, Musée Royal de l'Afrique Centrale	lepersonnite-(Gd)
Aimé Marthoz (1894-1962)	administrator, Union Minière du Haut-Katanga	marthozite
Achille Salée (1886-1932)	geologist, Université Catholique de Louvain	saléeite
Jacques Thoreau (1886-1973)	ore geologist, Université Catholique de Louvain	thoreaulite
Robert du Trieu de Terdonck (1889-1970)	mining engineer, Union Minière du Haut-Katanga	trieuite *
Edward Wayland (1888-1966)	geologist, Geological Survey of Uganda	waylandite

* non-valid species

Figure captions

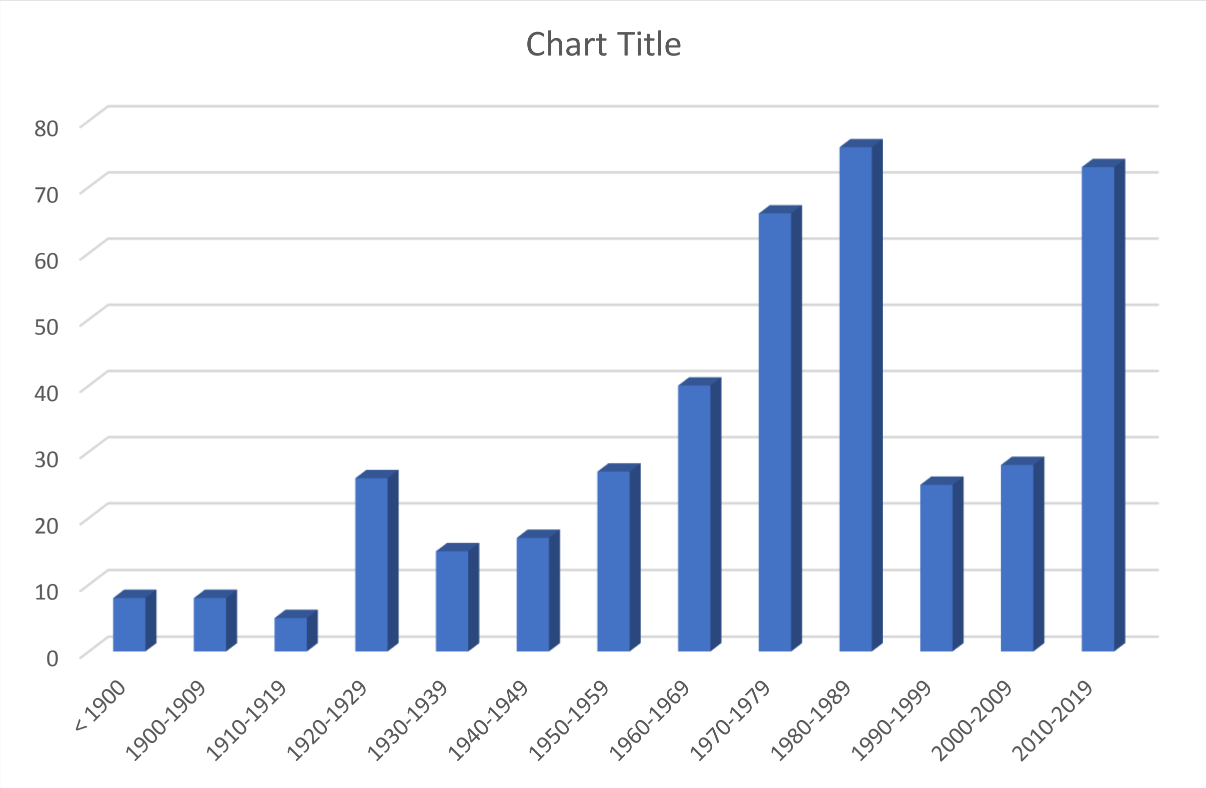

Figure 1. Number of valid mineral species described for Africa through time, by decennium.

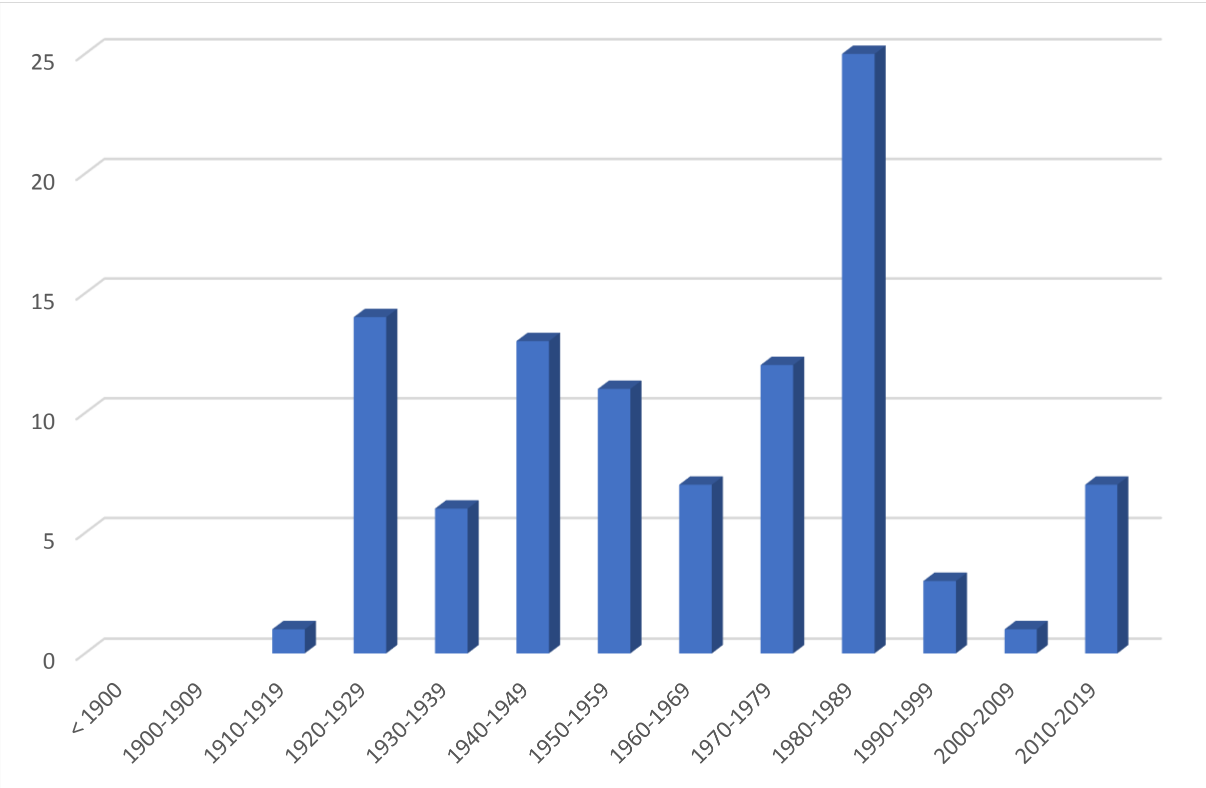

Figure 2. Number of valid mineral species described for the DR Congo, by decennium.