A CENSUS OF MINERAL SPECIES IN 2010

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Our census is an instantaneous view of the state of the population of mineral species. As in the case of a demographic census, it is necessarily subject to minor errors and omissions, but these do not change the overall picture. The census includes both unnamed minerals (new minerals but not sufficiently well documented to be officially named) and named species—those approved by the Commission of New Minerals, Nomenclature and Classification (CNMNC) of the International Mineralogical Association (http://pubsites.uws.edu.au/ima-cnmnc/). This community of unnamed minerals and named species has over 6000 members now, but it is continually growing and changing: new unnamed mineral species are validated; existing unnamed minerals are promoted by receiving a name; and existing minerals are renamed or discredited. The physical and chemical properties of each species also evolve as more data are added and the higher-level classifications of minerals are changed. The availability of databases of mineral properties puts us in a position to see a broad view of mineral properties and their variations much more easily and more accurately than at any time in the past. This census is based on the very substantial MinIdent-Win database (http://micronex.ca).

The development of mineralogy is mirrored by the discovery rate of new minerals (Fig 1). The number of minerals known in antiquity (~30) had not increased substantially by 1760. During the next 50 years the discovery rate climbed to about 10 new minerals per year and stayed there until the end of the 1950s when analysis by electron beam instruments became possible. From then on, the discovery rate climbed rapidly, rising to about 100 per year, or one every 4 days, in the 1980s and has diminished only slightly since that peak. The growth of mineral numbers also reflects the advances in crystallographic techniques and instrumentation and in particular our new ability to determine site occupancies accurately. Another effect may be the relative ease of the modern two-stage process of mineral identification: first, definition as a valid, unnamed species and, second, promotion to a named species when more complete data become available. Currently about 25% of mineral species remain unnamed.

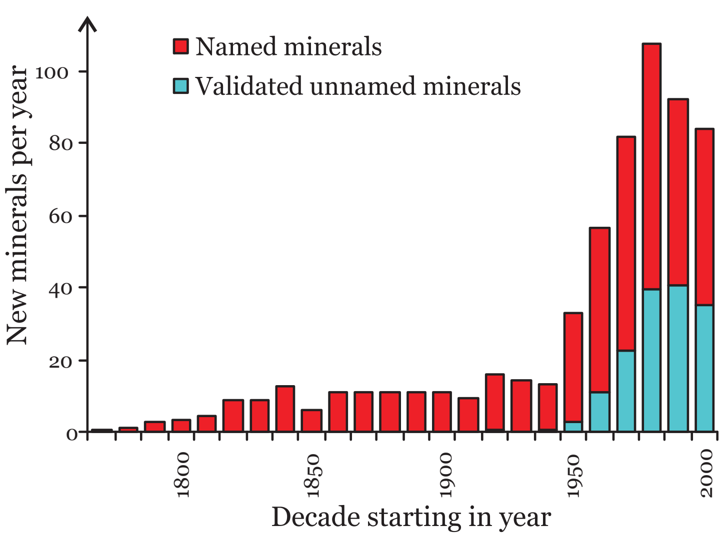

FIGURE 1 Compilation by decade of the date of the first description of named and validated unnamed mineral species. The numbers of unnamed minerals are for species currently thus classified—clearly in the past some of the currently named species were in the unnamed category.

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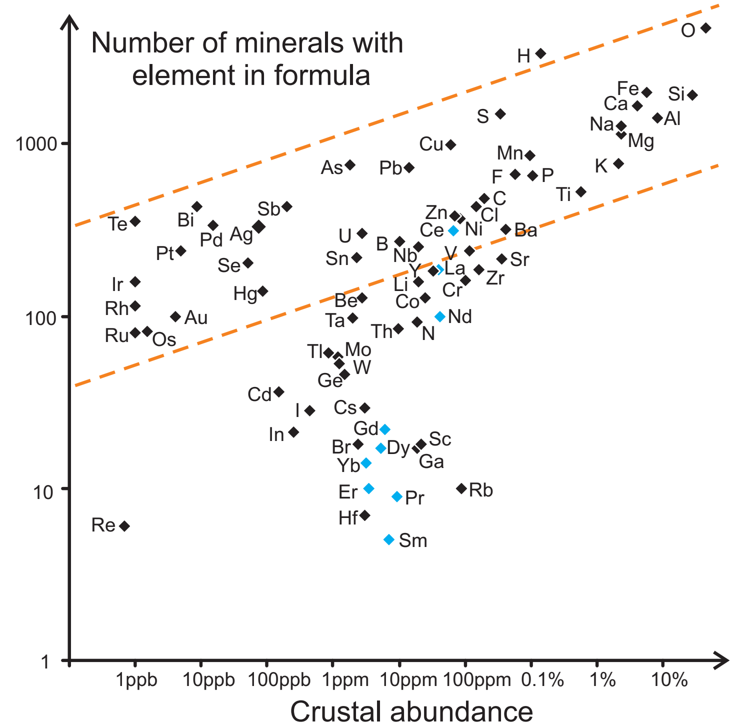

FIGURE 2 Numbers of minerals with specific elements in their formula versus the crustal abundance of that element (data from the *CRC Handbook*). Crustal abundance is used because most minerals are described from crustal rocks. However, the effects of different normalizations (mantle, etc.) are generally minor because of the logarithmic scales of the graph. Some elements are missing from all formulae and hence from this graph. Rare earth elements are in blue.

In a general way, the chemical compositions of minerals can be explored by looking at the elements in their formulae. O is the most common element, occurring in 76% of formulae, followed by H (53%), Fe (32%), Si (31%), Ca (27%), S (24%) and Al (23%). It is known that mineral formulae do not always reflect the actual composition of minerals, but how common is this? One way to explore this is to compare the number of minerals with an element in their formula with the number of minerals with that element as a significant component—here taken for simplicity as a mean analyzed composition greater than 1%. There is a very good 1:1 correlation between these measures, except for the rare earth elements heavier that Nd, which are commonly omitted from formulae.

Another way of looking at mineral compositions is by means of a graph of the number of minerals with the element in the formula versus crustal abundance (Fig. 2). More than two-thirds of the elements lie in a broad band across the diagram, indicating that the number of minerals that contain each element is correlated with the crustal abundance. That is, silicates are numerous because Si and O are abundant; minerals with Au are less numerous because this element is rare. This correlation also suggests that there are many more minerals of the less abundant elements waiting to be described. Within the correlation band, the non-metals (H, O, S, As and Te) are generally in more mineral formulae than metals, which is comforting as the broad classification of minerals is partly based on these elements (silicates, oxides, sulfides, etc.).

But what about the elements that lie beneath this band? They appear to lack their fair share of minerals. Some elements just below the correlation band form their own minerals, but these are not numerous: Mo, W, Th and N. Also, the presence of a number of rare earth elements in this part of the graph partly reflects the discrimination in formulae mentioned above, but it is also due to the great difficulty in determining REE accurately by microbeam techniques, resulting in their absence from many reported analyses. However, even if this is taken into account, REE minerals do seem to be less numerous than expected. The other elements below the band are a mixed bunch that seem to be genuinely camouflaged by similar but more abundant elements: Re, Hf, Rb, Ga, Sc, Br, I, In, Cs, Ge, Cd and Tl.