A Note on the Term “Chalcogen”

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Use of the term “chalcogen” to describe the members of group 16 of the periodic table (O, S, Se, Te, and Po) has now become common practice, not only in the inorganic and solid-state literature but, to an increasing extent, in introductory textbooks as well (*1, 2*). However, the origins of the term remain obscure. Most modern texts claim that it means “chalk former”, though other sources have suggested “calx former” and, in at least one case, “chain-former” as its literal meaning (*3–6*). I have also seen a claim that it means “glass former”, and one currently popular inorganic text manages to conflate it with the geochemical term “chalcophile”, used to characterize elements that tend to associate preferentially with copper in sulfide minerals (*7*). Other textbooks have suggested “brass giver” and “copper producing” as possible choices (*8, 9*).

Translation of the term as “chain former” is almost certainly wrong, a conclusion supported by the fact that the source in question failed to provide an etymological justification of this particular interpretation. The translations “calx former” and “chalk former”, on the other hand, are basically identical, as the word “chalk” is derived from the German word *kalk,* which is, in turn, a corruption of the Latin words for lime—*calc* or *calx* (*10*). These terms, in turn, are ultimately derived, as J. H. White has suggested, from the Greek word *chalix*, meaning “small stone, gravel, or pebble” (*11*). This interpretation appears reasonable from a chemical viewpoint as well, since the word “calx” was eventually generalized by 18th-century chemists so as to include compounds that Lavoisier later identified as oxides (*12*).

However, as plausible and as chemically attractive as these derivations may seem, there is little doubt that they are also wrong, and that the correct interpretation is closely related to our final two candidates—“brass giver” and “copper producing”. Both suggestions are alternative, but literal, translations of the Greek words *chalkos* and *gennae.* Unfortunately, when taken at face value, neither of these translations makes chemical sense, though both textbook authors attempted to rationalize them by arguing that the most important ores of copper are oxides and sulfides. But this is equally true of the ores of virtually every known metal and would literally imply that the term “chalcogen” applies to the oxide and sulfide ores themselves rather than to the elements oxygen and sulfur.

The best solution to this dilemma appears to be that given by Gunnar Hägg in 1969, when he suggested that “chalcogen” should be translated as “ore former” or “ore maker” (*13*). Originally the term *chalkos* did literally mean “copper or brass” and, as suggested by the term “chalcophile” mentioned above, the corresponding prefix “chalco-” is still used extensively in the geochemical and mineralogical literature in connection with the naming of copper-containing minerals, such as chalcopyrite ($CuFeS_2$), chalcocite (Cu_2S), and chalcophyllite ($Cu_7As_2O_{12}\cdot 14H_2O$). Since copper is often found in the native state, it was one of the first metals to be exploited by man. However, after the Greeks learned to chemically extract and work other metals, the term and its various derivatives gradually came to be associated with metals and metal working in general and with the naming of any stone or earth from which metal could be extracted—hence the logic of Hägg’s translation.

Not only is there a sound etymological basis for this interpretation; there is a good chemical basis as well, since, as already noted, virtually all important metal ores are either oxides or sulfides, and more than 99% of the more common minerals listed in the most recent editions of Dana’s *Manual of Mineralogy* are likewise either simple or complex oxides, sulfides, selenides, or tellurides (*14*). Further support comes from the translation of the geochemical term “chalcophile” as “ore loving” by Victor Goldschmidt, the geochemist who first coined the term, along with the terms “lithophile” (rock loving), “siderophile” (iron loving), “atmophile” (vapor loving) and “biophile” (life loving), as part of his well-known quintipartite classification of the geochemical distribution of the elements (*15*). Hägg’s interpretation can also be found in current German inorganic texts, where it is translated as *Erzbildner* (*16*).

I have frequently heard chemists pronounce the word “chalcogen” with a soft “ch” sound, probably because of its incorrect association with the word “chalk.” However, as the correct Greek derivation indicates, it should be pronounced with a hard “k” sound (i.e., as “kalkogen”), not unlike other chemical terms derived from Greek words containing the letter χ or chi, such as “chelate” and “stoichiometry.” Though official guides to inorganic nomenclature maintain that the resulting binary compounds of the chalcogens should be called “chalcogenides,” this is not in keeping with common usage for groups 15 and 17 (i.e., pnictogen/pnictide and halogen/halide), which suggests that the term “chalcide” would be more appropriate (*4*). Others have suggested use of the term “chalconide”, though this also fails to parallel usage with respect to the contractions used in forming such corresponding terms as “halide” and “pnictide” (*6, 17*).

In the course of researching this note, I also uncovered several examples of textbooks that imply that the term “chalcogen” should be used only for the heavier members of group 16 (S, Se, Te, and Po) (*9, 17, 18*). Although this was probably an unintentional result of having discussed the chemistry of oxygen in a separate chapter, it should, nevertheless, be emphasized that official guides to inorganic nomenclature are unanimous in their claim that the term applies equally to all of the elements in group 16 of the periodic table (*1, 2*).

As a final historical note, it is worth mentioning that the term chalcogen was not the first class descriptor to be proposed for the elements in group 16. In the first half of the 19th century, the Swedish chemist Jöns Jakob Berzelius, who first suggested the term “halogen” for the elements now found in group 17, also proposed that the current members of group 16 be called *corpora amphigenia* or “amphigens” and that their corresponding binary compounds be called “amphids” (*19*). This proposal was based on the dualistic theory, which Berzelius had inherited from Lavoisier and which viewed a salt as the additive product of an acid or nonmetallic oxide and a base or metallic oxide. Berzelius generalized Lavoisier’s original oxide system of acids, bases, and salts so as to include the corresponding sulfur, selenium, and tellurium systems. The term “amphigen” was intended to describe the ability of these elements to form both acidic and basic compounds, and had moderate usage in early 19th-century chemistry texts (*20*). The connection between acid–base theory and the prefix *amphi-* (from the Greek, *amphoteros*, meaning "both" or "of both kinds") is, of course, still present in modern chemical terminology, as reflected in our use of such terms as "amphoteric" and "amphiprotic."

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