

A Discussion of Some Definitions in Economic Geology

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A *mineral occurrence* is a natural concentration of a mineral, of no specified tonnage, which is anomalous by some measure. Note that qualitative features are important: is the occurrence just an “elevated” concentration of copper in an andesite, in which case it is not a mineral occurrence, or is the same elevated concentration due to chalcopyrite-bearing quartz veins surrounded by limonite?

A *mineral deposit* is a *mineral occurrence* of a type, size and grade that forms part of a continuum with those deposits that are possibly minable.

An **Ore Deposit** is a *mineral deposit* that can be mined at a profit, considering all geological and economic factors including grade, tonnage, accessibility, infrastructure, ore processing, etc. In as much as I only recognize “dominantly-free” markets as true economies, I offer no alternate definitions that do not rely on the concept of profit. {NB: the underlined portion is necessary and sufficient as a definition}. Further, in rare cases, the concentration of an element may not need to be much above “background”: for example, a rutile-bearing sand can be ore, even if the grade is not unusual, because the cost of separating the rutile from the gangue is low.

Showing: a mineral occurrence with no indicated economic feasibility; it may or may not warrant additional study.

Prospect: a mineral occurrence that has been drilled or investigated in some way, and which does warrant additional investigation.

Anomaly – without a qualifier, this term is vague, yet it is at the heart of all the above definitions (Beware the siren of “obviousness” – Bertrand Russell said that “obviousness is the enemy of correctness”). There are mineral anomalies and geochemical anomalies, defined statistically, but there are also gravity, induced polarization, and magnetic anomalies to name but a few, and these are also commonly used in mineral exploration. And what of alteration? When is alteration “anomalous”, as apposed to being just another exploration vector?

Therefore, we might define, generally, an *anomaly* as a local ‘deviation’ from the general surroundings, as defined geologically, geochemically, or geophysically. See my comments, above, regarding chalcopyrite and rutile.

Regarding *geochemical anomalies*, average crustal values are not very useful in defining an anomaly. One needs to establish the regional background. In a deeply weathered, or lateritic terrain, the background will be different from the background in a terrain

comprising, e.g., altered volcanic rocks. A threshold relative to the proper background may be defined, which may be the mean plus two standard deviations (sd), making a positive anomaly something in the upper ~2.5%. Even this (which was codified in the classic exploration text by Hawkes and Webb, 1962), is controversial. The fundamental flaw here, really, is that the background and the potential ore deposit are not part of the same “population”. The background may be due to variations in the copper content of, say, altered, glassy, volcanic rocks, and the anomalies you are looking for may be generated by chalcopyrite/bornite mixtures in quartz veins: two different populations. Therefore, picking the “upper ~2.5% or whatever is essentially meaningless, ASIDE from the issue of the arbitrariness of ~2.5. Further, each type of assay carries with it its own particular problems. For example, in evaluating stream samples, corrections need to be made for the stream order (Carranza, 2004).

Rather than use the properties of normal distributions, and estimate dubious parameters like the population mean and sd from data that violate the assumptions of normalcy, (e.g., drawn from one population, not skewed, independence of samples from each other, etc.), some workers now prefer using the median rather than the mean, and the median of the absolute deviation of all analyses from the median (the “median absolute deviation, or MAD), rather than the sd (Reimann, Filzmoser and Garrett, 2005). A positive anomaly is then defined as the median + 2MAD. See also their discussion of box and whisker plots, which is beyond this short treatment. The mean/sd approach yields extremes of a normal distribution, which ore deposits, for the most part, are NOT. Rather, most ores, statistically, are outliers (rather than extrema) and are due to the superposition of a second population on top of the background distribution of data.

Penultimately, there are the qualitative factors in the anomaly: if the background is 35 ppm Cu, and the sd is 10 ppm, and some assays come in at 100 ppm, are they worth a look? Sure. But, by using my example from above, what if they’re just samples from a copper-rich basaltic andesite? The basaltic andesite is not ore, and no portion of it will be found to reach ore concentrations. But, what if, instead, the anomaly is created by fine veinlets, and there are small masses of pyrite+chalcopyrite in a few of the veins, and THAT is what is bringing up the copper values? This is an example of a geological anomaly, which distinguishes the anomaly from a mere, uninteresting, geochemical anomaly.

Finally, note that the above definitions will vary from venue to venue, because of the fundamental difference between government/regulatory and industrial “best practice” norms.

There are plenty of discussions of Reserves and Resources, so I will leave that to others.

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