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On the interpretation of ACNK diagrams: weathering versus metasomatism

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ACNK ternary diagrams (i.e., with apices of Al_2O_3, $CaO+Na_2O$, and K_2O) are among the most widely used graphical tools for evaluation of chemical weathering patterns in soils and sediments. Unfortunately, correct application of ACNK diagrams has been compromised by misunderstandings concerning the nature of chemical weathering paths and the recognition of metasomatic effects that have propagated through the literature. Chemical weathering paths can vary considerably as a function of climate and other variables, even for weathering of essentially the same protolith (Fig. 1a vs 1b). Thus, the assumption of an "ideal weathering trend" running parallel to the A-CN axis (Fig. 1c) is generally unjustified and can lead to incorrect inferences regarding actual weathering paths, and therefore to erroneous assumptions regarding the presence (or not) of excess potassium (K) linked to metasomatism and to invalid "corrections" of CIA values. Metasomatic alteration generally leads to disruption of linear weathering paths in ACNK space; it is highly unlikely that K-metasomatism could operate on a sample array consisting of a well-defined weathering path and shift all the samples in a coordinated manner to produce a new array with an equal degree of alignment but an entirely different slope. Protolith reconstruction from a weathering path requires that the latter form a well-defined linear array that can be accurately projected backward to (or beyond) the feldspar join; projections based on poorly defined data arrays are meaningless. Moreover, while chemical evolutionary trends in unaltered soil successions must represent variation in degree of weathering intensity, such trends in sedimentary successions may alternatively represent two-component mixing systems; unlike the former, the latter provide no reliable information about chemical weathering paths. Finally, ACNK patterns in Paleoproterozoic formations that previously have been interpreted as due to K-metasomatism may, in fact, have an origin in synpedogenic processes linked to rising atmospheric oxygen levels, e.g., enhanced retention of K through early illitization of clay minerals. In summary, more nuanced use and interpretation of ACNK diagrams is necessary.

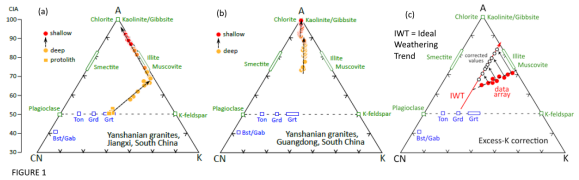

FIGURE 1