COMPOSITIONAL VARIATIONS IN METAMORPHOSED SEDIMENTS OF THE LITTLETON FORMATION, NEW HAMPSHIRE, AND THE CARRABASSETT FORMATION, MAINE, AT SUB-HAND SPECIMEN, OUTCROP, AND REGIONAL SCALES

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ABSTRACT

Rocks from several outcrops of low-grade Littleton Formation and laterally equivalent Carrabassett Formation were analyzed for major elements and Zr. Compositional variations well outside of analytical uncertainties were observed, in order of increasing magnitude, for the following: 10-gram subsamples from a 2-kg hand sample of visually homogeneous slate; 100-gram samples taken 10 meters apart in the same outcrop; 10-g subsamples from a visually homogeneous quartzite; samples of relict turbidite beds in the same outcrop; and single 100-g samples from seven outcrops. We regard these variations as inherited from the sedimentary protolith with little if any alteration over distance scales of centimeters or greater. All could be modeled successfully as mixtures mainly of clay, quartz, and chlorite-mica, although the compositions of the clay and the chlorite-mica components had to be adjusted for different sets of samples, within reasonable bounds for sedimentary-diagenetic minerals. Compositional variations and trends in 2-kg samples of higher-grade Littleton rocks are essentially the same as for the low-grade samples. For example, SiO_2 and Zr correlate positively, as expected for sedimentary sorting of quartz and zircon from clay, but not for selective metamorphic mobilization of silica. Also found was centimeter-scale separation of K_2O from Al_2O_3 and strong covariation of Zn with Al_2O_3 in ~10-g subsamples of a staurolite schist, compositional evidence of element transport over distances of a few centimeters. Because the protolith includes at least two major, Al_2O_3-bearing components in variable proportions, element ratios to Al_2O_3 can vary such that variation in metamorphic rocks need not be a sensitive indicator of element mobility relative to Al_2O_3 even if Al is immobile.
The population of low-grade rocks encompasses a broad compositional range. Thus, it is not feasible to obtain a sample average with a small standard deviation. It would also be difficult to demonstrate conclusively whether a set of samples was representative of its metamorphic grade, or whether rocks of all metamorphic grades developed from the same combination of protolith compositions and physical characteristics.