GEOCHEMICAL CHARACTERIZATION OF THE ACADIAN OROGENY IN THE CHESTER DOME REGION, VERMONT

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Several major orogenic events have been distinguished within the rocks of the northern Appalachians: a Proterozoic Y (Grenvillian) high grade event, a Proterozoic Z low grade event, the Taconic Orogeny of Ordovician age, a Devonian Acadian event that involved and domed basement rocks, and a Pennsylvanian-Permian regional metamorphism (Robinson, 1982). The superposition of multiple metamorphic and deformational events produced complicated structures and fabrics. The intensity of overprinting by Acadian deformation and metamorphism varies throughout New England, but severely overprints earlier events in southeastern Vermont thereby obscuring the pre-Acadian history (Karabinos, 1984). Interpretation of multiply deformed and metamorphosed rocks is greatly facilitated if the conditions of the last event are well characterized. In order to aid in the interpretation of polymetamorphic features in southeast Vermont, this study aims to document the conditions of the Acadian orogeny around the Chester dome and deduce regional trends in the thermal evolution of this area.

The Chester dome is composed of 1 b.y. Grenvillian basement rocks that are overlain by a sedimentary and volcanic sequence of Siluro-Devonian age. Polyphase Acadian deformation has folded the basement and cover into a structural dome. In order to sample rocks that were affected only by the Acadian orogeny, samples were collected only from the post-Taconian portion of the cover sequence. The Waites River Formation, a sequence of alternating micaceous limestone and graphitic phyllite of lower Devonian age, dominates the outcrop in this region. Samples were also collected from the Gile Mountain Formation, a sequence of alternating dark schists and quartzites, and the Northfield Formation, composed of graphitic and carbonaceous phyllites to schists. (See Fig. 1)

Over 120 samples were collected in the field and sixty thin sections prepared for petrographic description and interpretation of phase relations. Six sections were then selected for microprobe analysis, which provides data to calculate pressures and temperatures of 'peak' metamorphic assemblages. Topologies of equilibrium assemblages, deduced from petrographic study of 60 thin sections, are generally consistent with garnet grade metamorphism. Common assemblages were quartz + muscovite + garnet + biotite ± plagioclase ± chlorite ± calcite with common accessory phases of tourmaline ± zircon ± zoisite. The matrix generally consists of fine grained muscovite + biotite + graphite ± illmenite ± pyrite. In some pelitic samples, a crenulation cleavage is folded into cm-scale folds, evidencing three deformational events. Trivarient AFM assembleges (garnet + biotite) dominate the sample suite although divarient (garnet + biotite + chlorite) were observed in some samples. Plagioclase phoroblast are commonly broken and overgrown by the dominant schistocity and are interpreted to be equilibrium with these AFM assembleges. Some samples, taken from the carbonaceous layers, contain calcite and zoisite with AFM phases. To graphically represent these phases, Ca was added to the standard AFM projection. The geometry of tie lines on such diagrams is important in distinguishing the effects of rock composition and grade of metamorphism. Biotite grade metamorphism was inferred by the limited AFM topology alone. The fine grained textures of these samples, however, does not seem consistent with this metamorphic grade.

The garnet grade AFM topology is characterized by the stability of the tie-line between garnet and chlorite. The presence of additional components (particularly Mn and Ca), however, expands the stability of the assemblege garnet + chlorite through a wide of temperatures. Relative to staurolite + biotite, garnet + chlorite can be stable at higher temperatures and pressures (Spear and Cheney, 1989). The stability of the garnet + chlorite tie line on an AFM projection does not uniquely correspond to a specific grade of metamorphism. Garnet rims analyzed in this study have as much as twenty mole percent additional components (spessertine and grossular).

Preliminary geothermobarometry results based on the garnet-biotite geothermometer (Ferry and Spear, 1978) and garnet-biotite-muscovite-plagioclase geobarometry (Hodges and Crowley, 1985) for samples from each of the north, south, and west flanks of the Chester dome. (See Fig. 2) When possible, separate areas within a slide were used for these calculations in order to check for equilibrium at thin section scale. Temperatures and pressures are generally lower to the north (475°C and 6.7 Kbars) and higher to the south (500 to 550°C and 6.7 to 9.5 Kbars). The sample to the west yields inconsistent results (difference of 1 Kbar and 50°C) which may be caused by exchange of Fe and Mg between garnet and biotite upon cooling or late growth of chlorite splays taking up Fe or Mg from the biotites. Fe/Mg ratios in biotite decrease from the northern sample, with Fe/Mg ratios averaging 1.5, to the west, averaging about 1.4, and south, averaging about 1.1. The southern Mg-rich biotites, which replace muscovite as the modally dominant matrix phase, have the highest K/(K+Na) ratios, averaging about 0.988. The biotites from the west and north both average about 0.97.

Staurolite grade metamorphism, evidenced by broken phoroblasts of kyanite and staurolite overgrown by a fine grained biotite + muscovite matrix, does occur south of the dome.

These results remain tentative pending detailed analysis of the partioning of Fe and Mg between garnet and retrograde chlorite. P-T-t paths also remain to be calculated based on garnet zoning data collected from the microprobe. A zoning profile, such as the one in Figure 3, shows the partioning of Fe, Ca, Mg, and Mn which provides the chemical basis for back calculating the P-T history of the sample. The geometry of these paths will be compared to the paths calculated for Acadian trajectories in New Hampshire and Massachusetts (Robinson, et al, 1986 and Spear, 1986). Continued thermodynamic analysis will provide information on the metamorphic evolution of samples throughout the region and provide for an understanding of the thermal history of domed regions.

References

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Generalized Geologic Map of the Chester Dome Region, Southern Vermont

(after Doll et al., 1961)

Figure 1

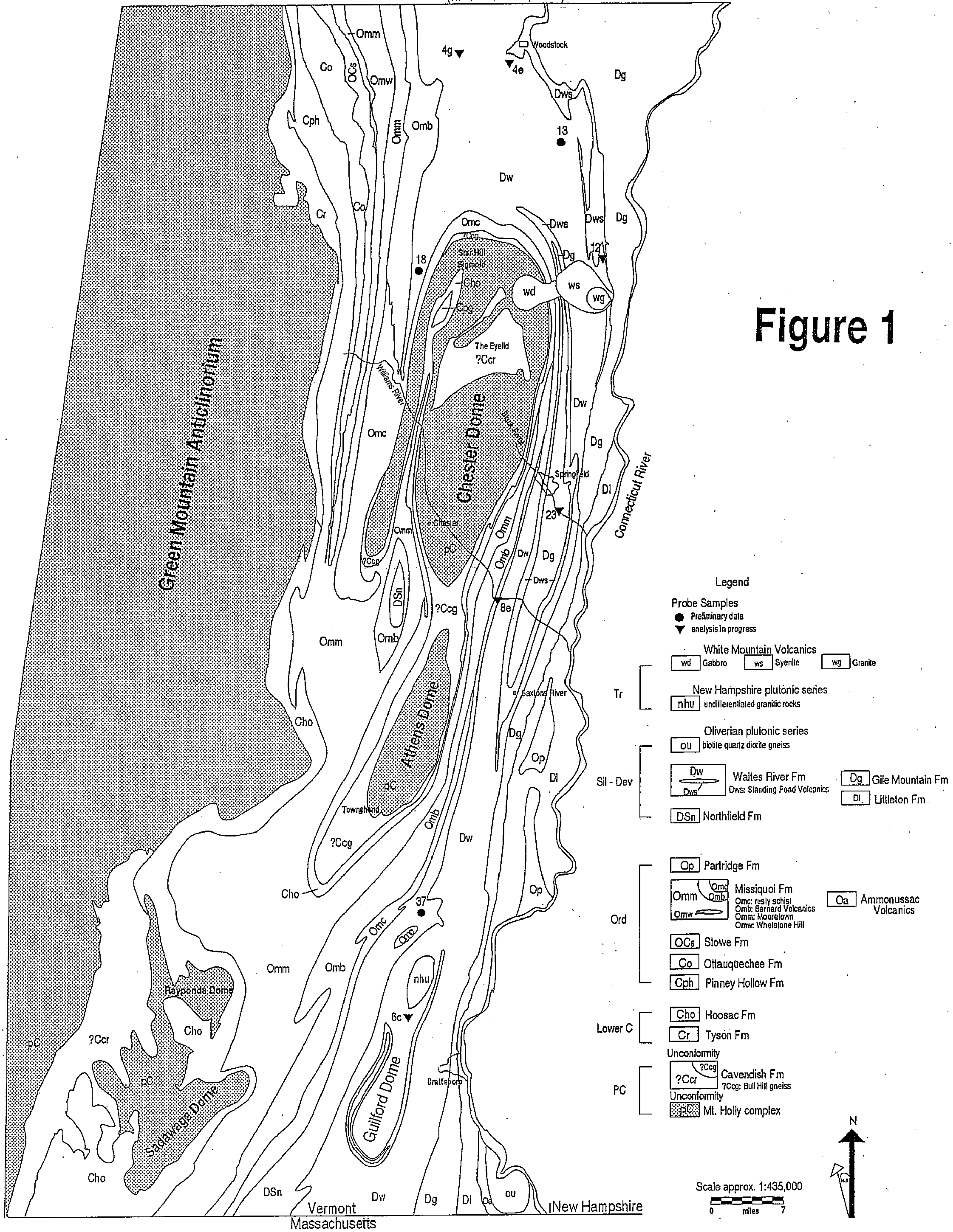
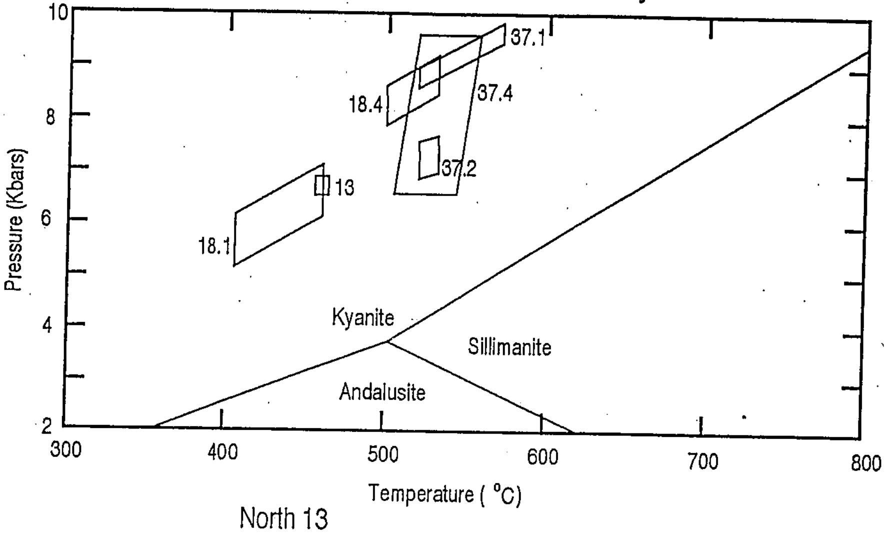


Figure 2: Preliminary Results from Geothermobarometry



North 13
West 18.two areas on thin section analyzed
South 37.three areas

Figure 3: Garnet Zoning Profile, Slide 18.4