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SUPPLEMENTAL ROAD LOG 1, FROM SANTA FE TO SANTA FE SKI AREA VIA HYDE PARK ROAD

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SUMMARY

This road log describes the geology along NM-475, which runs for 15 mi from the city of Santa Fe to the parking lot of the Santa Fe ski area. The Borrego fault, a major N-striking high-angle fault running the length of the Santa Fe Range (see Metcalf, this volume), divides the geology of NM-475 into two parts. The lower 7.2 mi, below Hyde State Park, lies west of the Borrego fault. Rocks along this section consist mainly of Proterozoic supracrustal rocks, felsic gneiss and amphibolite, intruded by granite and granitic pegmatite. In addition, this section contains the only outcrops of Paleozoic rocks within the Santa Fe Range. Hyde State Park lies within the trace of the Borrego fault. Above Hyde State Park, the road passes to the east of the Borrego fault into the metasupracrustal and plutonic rocks that form the batholithic assemblages of the central and northern Santa Fe Range. This road log focuses on the Proterozoic plutonic rocks of the central Santa Fe Range with six formal stops along the upper 6.3 mi of the road.

Bedrock geology along NM-475 east of the Borrego fault is composed exclusively of Proterozoic crystalline basement. The rocks of the central Santa Fe Range can be divided into four major groups. These are, in order of decreasing relative age, (1) a suite of upper amphibolite facies migmatitic supracrustal rocks composed of biotite gneiss, felsic gneiss and amphibolite; (2) a suite of foliated, megacrystic felsic granitoid rocks (granites); (3) a suite of relatively undeformed mafic granitoid rocks (diorite and tonalites); and (4) small bodies and dikes of alkali granite and granitic pegmatite. Metcalf (1990; this volume) provides discussion of the geology of the central Santa Fe Range, east of the Borrego fault. Metcalf (1990) focused primarily on the migmatites and Metcalf (this volume) focuses primarily on the plutonic rocks.

Mileage

0.0 Intersection of Washington Ave. (also known as Bishops Lodge Road) and Artists Road (NM-475). Turn onto Artists Road and proceed east. **0.5**

0.5 Views of Thompson Peak at about 2:00 and Santa Fe ski area at 11:00. **1.1**

1.6 Exposures of Proterozoic amphibolite and felsic gneiss intruded by pegmatite dikes on left side of road. **0.7**

2.3 More amphibolite and felsic gneiss intruded by pegmatite, next 0.9 mi. **1.2**

3.5 Ten Thousand Waves (hot tub establishment) on left. **0.1**

3.6 Outcrops of Paleozoic carbonate rocks on right. **0.3**

3.9 Great unconformity between Proterozoic basement and overlying Paleozoic carbonate rocks. **0.2**

4.1 Sharp right bend in road; more Paleozoic carbonate rocks across valley to the left. There is a small pull-out on the left you can use if you wish to view the unconformity, but be extremely careful of oncoming traffic when you pull out. Also be cautious of traffic when viewing the outcrop. **0.3**

4.4 Amphibolite and felsic gneiss intruded by pegmatites on left, next 0.3 mi. **0.4**

4.8 Numerous outcrops of granite containing screens of amphibolite for next 0.5 mi. **0.8**

5.6 Trail head for the Chamisa Trail 182. A large fault trending 010° runs through this valley; a 0.25 mi walk to where the valley first narrows allows examination of fault breccia on south side. **0.2**

5.8 Amphibolite with both concordant and discordant pegmatite bodies. **0.1**

5.9 Good exposures of amphibolite intruded by granite. Granite contacts are mainly intrusive but contacts are faults. **0.3**

6.2 More amphibolite intruded by granite, next 0.2 mi. **0.3**

6.5 Good exposure of a small recumbent fold in amphibolite on left. Note mineral lineations that wrap around the fold. **0.7**

7.2 Road turns left and travels north along the trace of the Borrego fault. **0.2**

7.4 Entering Hyde State Park. **0.1**

7.5 Evergreen Restaurant on right. **1.2**

8.7 Road curves to right and leaves the trace of the Borrego fault. On the left is a parking area for the trailhead to the Borrego Trail. **0.1**

8.8 Exposures of brecciated felsic gneiss and megacrystic granite adjacent to the Borrego fault. For the next 1.7 mi numerous roadcuts provide exposures of deformed megacrystic granite, felsic gneiss and amphibolite (see description at Stop 1). **0.7**

9.5 **STOP 1. Pull off to the left** just as road turns to the right. (Watch for vehicles coming down the mountain as you turn in; their visibility will be limited.) The roadcut between here and mile 9.6 (bend in road at small stream at far end of roadcut) is composed of megacrystic granite, felsic gneiss and amphibolite. The megacrystic granite belongs to the older felsic granitoid group within the calc-alkaline plutonic series. Felsic gneiss and amphibolite of the central Santa Fe Range have been interpreted as supracrustal lithologies, probably metavolcanic rocks, into which the megacrystic granite intruded. The granite and the supracrustal rocks experienced ductile deformation associated with peak metamorphism in the central Santa Fe Range (Metcalf, 1990). At the far end of the roadcut both the supracrustal rocks and megacrystic granite are intruded by dikes of hornblende biotite tonalite. These dikes appear to be related to a large hornblende biotite tonalite pluton just to the north. Some tonalite here exhibits a weak subsolidus fabric (see dike outcrops across the stream and about 3 m above the road). **0.2**

9.7 Cross into the hornblende biotite tonalite pluton. This is the southern hornblende biotite tonalite pluton shown in

Figure 1a in Metcalf (this volume). The southern border of the pluton is not well exposed along the road. The northern border can be examined at Stop 4. **0.1**

9.8 Ahead, for the next mile, large outcrops of tonalite are cut by numerous dikes of alkalic granite and pegmatite. **1.1**

10.9 **STOP 2. Pull off on left side of road.** Small outcrop on left and large roadcut on right expose hornblende biotite tonalite. These rocks are part of the mafic granitoid suite, here composed primarily of plagioclase, biotite, hornblende, and quartz with minor K-feldspar. The small honey-brown crystals seen in hand sample are accessory sphene. The tonalite contains small mafic enclaves composed of hornblende, biotite and plagioclase. Numerous dikes of alkali granite and pegmatite intrude the tonalite. Some of the tonalite exhibits a weak planar fabric, seen best in the small outcrop on the left side of the road. This fabric is defined by the alignment of ferromagnesian minerals, mainly biotite. Plagioclase, however, is sub- to euhedral and quartz is equant, suggesting a magmatic flow foliation rather than a subsolidus deformation fabric. Note that many of the mafic enclaves are flattened and lie within the plane of the foliation. **0.3**

11.2 Small pull-out on right at a water monitoring station. **0.1**

11.3 **STOP 3. Pull off on left side of road.** Outcrops on the right are biotite-bearing hornblende tonalite (to quartz diorite). They are somewhat more mafic those than at Stop 2 (more hornblende, less quartz). The tonalite is cut by both an aplite dike and numerous dikes of alkali granite and pegmatite. Aplite dikes in the central Santa Fe Range are a feature unique to plutons of the mafic granitoid group. The aplite dike is cut by small pegmatite dikes. Hornblende geobarometry on a sample taken from this outcrop yields a pressure of 7.5 kbars, consistent with a depth of crystallization of about 28 km. This pressure estimate is somewhat higher than that reported from elsewhere in the central Santa Fe Range (5.5 kbars based on metamorphic geobarometers in migmatites at Aspen Basin; Metcalf, 1990). **0.5**

11.8 Large block of felsic gneiss within the hornblende biotite tonalite pluton. **0.1**

11.9 **STOP 4. Pull off to right** at the Big Tesuque campground or up the hill on the left near Milepost 12. This stop marks the northern margin of the hornblende biotite tonalite pluton. Here the pluton intrudes migmatitic supracrustal lithologies, primarily felsic gneiss with minor amphibolite and biotite gneiss. The supracrustal rocks exhibit an S1 planar fabric composed of combined compositional layering and an internal mica foliation. The compositional layering is formed by an interlayering of leucosomes (melted granitic portion) and mesosome (unmelted gneissic portion), as well as an interlayering of lithologic types (felsic gneiss, amphibolite and biotite gneiss). The leucosomes formed by in situ partial melting at the peak of metamorphism. Migmatite leucosomes cross-cut the S1 fabric, indicating that leucosome crystallization occurred after D1 deformation had waned. Thus, the thermal peak of metamorphism must have outlasted deformation.

The tonalite here is less mafic than in the central part of the pluton and is similar to that near the southern margin (i.e., Stops 1 and 2). At the outcrops nearest the Tesuque campground (just north of the creek), the pluton cross-cuts the S1 fabric in the supracrustal rocks. Emplacement of the pluton, therefore, post-dates D1 deformation. As you walk up the roadcut from the creek, you will pass through several tens of meters of migmatitic supracrustal rock. Beginning just before the sharp right bend in the road, and continuing around the bend, are several small dikes and apophyses of tonalite intruding the migmatitic supracrustal rocks. Carefully examine the first of these tonalite bodies (just before the right bend in the road). Notice that the tonalite becomes more felsic where it encounters the granitic leucosomes. This relationship suggests commingling of tonalite magma with granitic leucosome magma. If correct, this would indicate that tonalite intrusion was contemporaneous with the migmatization event and, therefore, the thermal peak of metamorphism. Metamorphic temperatures recorded by the migmatites of the central Santa Fe Range are about 100°C higher than temperatures typically recorded by metamorphic rocks in most other areas of northern New Mexico (Grambling et al. 1989; Metcalf, 1990). The timing relationships at this stop raise the possibility that heat advection, related to emplacement of mafic group plutons, was partially responsible for this anomalous metamorphic event. **0.5**

12.4 Forest Service road 102 (Pacheco Canyon road) turns off to the left. Portions of road 102 may not be passable for low clearance vehicles. **0.7**

13.1 Pull-out for Aspen Vista scenic overview. **0.8**

13.9 **STOP 5. Pull off on right side of road** near the bottom of the hill. The roadcut is composed of several Proterozoic lithologies. Most of the roadcut is migmatitic felsic gneiss, with lesser amounts of migmatitic biotite gneiss and amphibolite gneiss. Note that a composite S1 foliation within the supracrustal is defined by coplanar elements of compositional layering and an internal mica foliation. Several centimeter- to meter-scale layers of megacrystic biotite granite (part of the older felsic granitoid group) are present in the middle to upper part of the roadcut. This granite has a subsolidus S1 foliation defined by the alignment of biotite mats and deformed feldspar megacrysts. Also note the coplanar nature of S1 in the migmatites and S1 in the granite. Emplacement and crystallization of the megacrystic biotite granite must have predated D1 deformation. A large, compositionally zoned granitic pegmatite dike cross-cuts the supracrustal rocks at the lower end of the roadcut. **0.7**

14.6 A narrow (2–3 m) screen of megacrystic granitoid rock is exposed in the roadcut on the right. This screen separates two blocks of migmatitic supracrustal rocks, one to the south dominated by felsic gneiss and one to the north dominated by biotite gneiss. The north block is referred to as the Aspen Basin septum (Metcalf, 1990; this volume). **0.2**

14.8 Turn left into ski basin parking lot. **0.2**

15.0 **STOP 6. Park near the gates** to the Santa Fe ski area's upper parking lot just below the ski lodge and the base of the quad ski lift (the Super Chief). (Note: the upper parking lot is closed to vehicle access during the off season and is locked at the end of the day, so be sure to park outside the gate). You are now within the migmatite complex of the Aspen Basin septum. The best migmatite exposures are in the upper portions of the ski area, particularly along the north side of the valley. Boulders of the migmatite in the slopes above can be found along the edges on the parking area.

Migmatites in general can be divided into (1) an igneous looking part called a leucosome; (2) a mica-rich, schistose portion called a melanosome; and (3) a gneissic portion called a mesosome. In anatectic migmatites such as these (i.e., formed by partial melting), leucosomes represent the partial melt, melanosomes represent the residual solids that did not enter the melt, and mesosomes represent portions of the rock body that did not experience melting. Most boulders surrounding the parking are composed of the biotite gneiss migmatite unit. Two leucosome types are present: (1) a trondhjemite leucosome composed primarily of plagioclase (An25), quartz and muscovite; and (2) a granitic leucosome composed primarily of plagioclase (An18), microcline, quartz and muscovite with or without accessory garnet. Melanosomes are composed primarily of muscovite, biotite and oxide minerals (magnetite and ilmenohematite); accessory minerals can include garnet, sillimanite, quartz and apatite. Mesosomes are composed primarily of plagioclase, quartz and biotite with accessory garnet and sometimes muscovite. Leucosomes exhibit igneous microstructures; melanosomes and mesosomes exhibit metamorphic microstructures. Sillimanite is not found in association with microcline anywhere in the migmatite complex, indicating metamorphism at conditions below the second sillimanite isograd. Metcalf (1990) estimated peak conditions at T=650-730°C and P=5.2-5.5 kbars based on a combination of the petrogenetic grid and quantitative thermobarometry.

End of Supplemental Road Log 1.

Day 1 Stop 1A