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Chulitna District Paleomagnetic Study, 1998

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Paleomagnetic Techniques in Terrane Analysis

Relative movements between tectonostratigraphic terranes is common. One of the primary means of determining the amount of displacement, particularly in terms of latitudinal changes, is the making use of paleomagnetic data. The angle that the geomagnetic field lines make with the surface of the earth, the angle of inclination, gives a measure of the geomagnetic latitude. On the assumption that the earth's field can be represented by a geocentric dipole field, the inclination of the field with respect to ancient horizontal as recorded in the rocks can give the geomagnetic paleolatitude. On the further assumption that the dipole and spin axes of the earth coincide when time-averaged, the geographic paleolatitude can be deduced. Paleomagnetic pole positions can also be calculated, but are dependant on being able to unfold any tectonic deformation that has taken place, and are thus inherently less accurate.

All the samples collected for this study are from igneous rocks, so the acquisition of magnetic records by sedimentary rocks will not be discussed here. Igneous rocks can acquire a magnetic signature in several ways. Two important processes are thermoremnant magnetization (TRM) and chemical remanent magnetization (CRM). TRM is the magnetization acquired as rocks cool from above their magnetic blocking temperatures. The magnetic moments of magnetic particles in the cooling rock will align with the ambient magnetic field. Once the rocks cool below the blocking temperature, the magnetic moments become fixed within the rock. The second process of magnetization, CRM, is acquired during processes such as metamorphic events where minerals form, or are altered while below their Blocking temperatures, the magnetic moments of magnetic grains will again align to the ambient magnetic field at the time of their growth. When rocks are magnetized the magnetization is manifested as a vector component within the rock. It is possible for a rock to have more than one component of magnetization, each residing in a different stability regime usually controlled by temperature. The most stable (commonly the highest temperature) components are referred to as the characteristic magnetization, weaker components are commonly related to later overprinting events.

To separate out the various components during a paleomagnetic study, samples are subjected to a procedure in which they are heated to progressively higher temperatures, cooled in a zero field and remeasured. A similar procedure is carried out using alternating magnetic fields, increasing the peak demagnetizing field with each step. After each step of heating or alternating field application, the samples are analyzed in a magnetometer and the directions of the magnetic vector components of the sample are plotted. With increased heat or peak field, the vector components affected by any given level are randomized resulting in a net zero vector. Thus during demagnetization, less stable components are lost first. The most stable vector component is the characteristic magnetization.

Field Season, 1998

Field work involved sampling rocks of the Upper Chulitna district (fig. 1) for paleomagnetic measurements. Several localities representing rocks of different ages and lithologies were cored. In all, 17 sites from 5 localities were drilled using a portable drilling apparatus giving a total of 51 samples. All localities were remote and were reached by helicopter.

Preliminary measurements have been made on the main target of the exercise, the Triassic basalt-limestone sections. These were sampled at Localities 1 and 4.

Locality 1 McCallie Creek Triassic limestones and basalts

A helicopter landing site in McCallie Creek provided access both upstream as well as up slope. The valley walls are steep sided, with exceptional outcrops beginning halfway up the walls. Rock outcroppings at creek level were less frequent and commonly overgrown with vegetation or snow covered. Arguments as to whether lower outcrops were in place or not were found difficult to resolve in the field. Along our section of the creek, spectacular outcroppings of a succession of strikingly banded alternating thick basalt units (up to several meters) and limestone beds were seen along the upper portions of both sides of the valley, the more impressive being on the northern wall. Seven distinct basalt units were sampled. The lowermost basalt unit was at creek level. The second through seventh units sampled were up-slope. This pillow basalt-limestone unit is Triassic in age (Jones et al, 1980). The basalt layers are all similar in appearance and contain scattered and broken pillows. The pillows are small, less than 30 cm. in diameter. The limestone has been lightly marbleized. The contacts between the basalt and limestone layers are marked by a zone about half a meter thick. The limestone at these zones contains massive crystalline calcite and the basalt contains serpentenized rock (Hawley and Clark, 1974). The lower contacts of the basalt layers where they meet the limestone beds are vesicular. At one such contact, fossil shells were found entrained in the basalt, about 10 cm. up from the limestone. This discovery was made by Dr. Rainer Newberry and provides positive information that the sequence is right side up. The rocks in this unit are dipping at 42 degrees to the WNW. Local faults were observed, making stratigraphic thickness measurements difficult to obtain. As reported by Jones *et al.* as well as by Hillhouse and Gromme, the base of this unit was not exposed at this locality, thus a complete stratigraphic description is not available.

Locality 4. Ohio Creek Triassic limestones and basalts

Two sites were sampled halfway up the ridge dividing the Ohio and Christy Creek drainages. A small ledge provided a suitable landing spot and gave access to outcroppings of a basalt, part of the Triassic alternating pillow basalt-limestone unit. The basalt flows sampled here are not the next flows in stratigraphic succession after the flows sampled at the first locality. Several flows after the seventh site were found to be inaccessible and they outcropped towards the top of the ridges where lightning may have seriously altered the original magnetization.

Locality 2

Two sites were drilled in Permian basalt flows in an upper tributary of Long Creek. The beds are nearly vertical and on strike parallel with the creek. The locality is about 17m downstream from the termination of the Permian redbeds unit.

Locality 3

Two sites were drilled in Cretaceous dikes one mile east of the Golden Zone mine.

Locality 5

Four sites were drilled at Long Creek, at creek level. These sites represent Permo-Pennsylvanian greenstones.

<u>Sample Analysis</u>

Four of the seven sites drilled at locality one were sub-sampled and paleomagnetic measurements carried out. In the samples analyzed, it was found that two vector components were predominant. The site average of the characteristic vector components of all of the samples was calculated to have a 43° inclination. Using the equation relating inclination (I) to latitude:

$$\tan I = 2\,[\tan \text{latitude}]$$

A paleolatitude of 25° was found for the site. This latitude is consistent with the geologic evidence presented by Jones *et al.* A site average for the overprint was also calculated. This overprint was found to be near vertical, which is consistent with the overprint vectors of other terranes in southern Alaska.

<u>Conclusions and Future Work</u>

The paleomagnetic signature of the rocks sampled in this study, give an inclination of the ancient field which corresponds to a paleolatitude of formation at 25°. Because it is not known whether these rocks were normally or reversely magnetized, it is not known whether this represents a paleolatitude north of south of the equator. The very steeply dipping secondary magnetization is probably related to the time of accretion of the Chulitna terrane, and is similar to the remagnetization vectors seen in many of the surrounding terranes.

These conclusions are tentative since the remainder of the samples have yet be measured, however, the preliminary analysis of samples collected from other localities indicate that the magnetic signatures will give similar results.

	Longitude			Latitude		
Loc. 1	-149	52	59.41	63	6	51.12
Loc. 2	-149	40	4.512	63	10	14.844
Loc. 3	-149	37	13.76	63	12	49.824
Loc. 4	-149	51	8.352	63	8	58.416
Loc. 5	-149	41	18.46	63	12	8.496

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