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PROCEEDINGS OF THE TWENTY-FIFTH ANNUAL KECK RESEARCH SYMPOSIUM IN GEOLOGY

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Students: *EMILY JOHNSON*, Whitman College, *BENJAMIN CARLSON*, Union College, *LUCY MINER*, Macalester College, *STEVEN ESPINOSA*, University of Texas-El Paso, *HANNAH HILBERT-WOLF*, Carleton College, *SARAH OLIVAS*, University of Texas-El Paso.

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Research Advisor: Terry Pavlis

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SARAH J. OLIVAS, University of Texas at El Paso
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PALEOMAGNETISM OF THE KNIGHT ISLAND OPHIOLITE, PRINCE WILLIAM SOUND, ALASKA

STEVEN ESPINOSA,University of Texas at El Paso
Research Advisor: Terry Pavlis

INTRODUCTION

The Knight Island ophiolite, within the Chugach-Prince William Sound terrane (CPW), formed along a trench-ridge-trench (TRT) boundary (Bradley et al., 2003). Previous work on the paleomagnetism of the Knight Island ophiolite reveals a complex history of overprinting thus not yielding a reliable paleomagnetic pole (Bol, 1993). In this project, we focus sampling to the sheeted dike complex of the ophiolite because it might be more resistant to chemical alteration than the pillow basalts, and using chilled margins to determine orientation should provide a better indicator of paleohorizontal than estimation from pillow basalt tops.

Two modern hypotheses provide an account of the transport of the Prince William Sound terrane to its current position. The in situ hypothesis suggests the CPW terranes as a terrane formed more-or-less in place and its formation is directly related to the proposed Resurrection plate (Haeussler et al. 2003). The Baranof-Leech River hypothesis suggests that transport was coast-parallel along the Pacific/North American plate margin (Cowan et al. 2003). Dextral strike slip faults will have displaced the southern terranes northward from modern British Columbia (; (Cowan et al. 1997; Cowan 2003). The age succession of plutons from Baranof Island in SE Alaska to Sanak Island, known as the Sanak-Baranof belt, is either interpreted as a northward migrating TRT triple junction (Haeussler et al. 2003) or ridge subduction that occurred far to the south (Cowan, 2003).

Previous work on the paleomagnetism in the CPW terrane has determined transport by as much as 13° (Bol et al. 1992) supporting the Leech-Baranof hypothesis. The Resurrection hypothesis rejects the paleomagnetic data due to concerns of overprinting and a lack of a clear relationship between sediments and the Resurrection Peninsula ophiolite (see Haeussler et al, 2003). By determining the paleolatitude of the Knight Island ophiolite we can determine the position of the spreading ridge that created the ophiolitic sequence, and the path these rocks might have traveled (coastwise or deep ocean) to reach its current position. By determining the transport of CPW we can answer important questions about for the role of these relatively young intrusions in Prince William Sound, and ultimately, the source of the CPW terrane.

TECTONIC AND GEOLOGIC SETTING

This part of southern Alaska is composed of a Mesozoic and Cenozoic accretionary prism primarily consisting of the Chugach and Prince William terranes (Coney et. al., 1980; Plafker, 1994). The two terranes are commonly referred to as the Chugach-Prince William terrane (CPW). These terranes are bound to the north by the Border Range Fault and the more inboard Insular terrane (Plafker, 1994; Pavlis, 1982). The southern boundary of these terranes is the Pacific plate margin against the North American plate known as the Aleutian Trench (Plafker 1994). Southern Alaska is also dominated by a number of important dextral strike slip faults in addition to the Border Range Fault including the Queen Charlotte-Fairweather and the Denali fault (Plafker 1994).

The Paleocene Knight Island ophiolite is an ophiolitic sequence located in the CPW terrane which consists of a sequence of pillow basalts and with interbedded clastic sediments of the Orca flysch and a sheeted dike complex, which likely formed near a trench-ridge-trench (TRT) triple junction (Nelson and Nelson, 1992; Lytwyn et al., 1997). Formation of the ophiolite is assumed to be 57 Ma due to geochemical similarities to the well dated neighboring Resurrection Peninsula ophiolite (Nelson et al. 1989; Lytwyn et al., 1997). It has also been suggested that the basaltic basement rocks that underlie part of the Yakutat terrane (to the east) is source of basalts and mafic rocks, such as those in the ophiolitic suites, in Prince William Sound and Resurrection Bay (Lytwyn et al., 1997; Bruand et al., 2011).

The Eshamy Suite of plutons, located in western Prince William Sound, intruded rocks surrounding the Knight Island ophiolite between 37 and 40Ma. These rocks have geochemical similarities with the Caribou Creek volcanics to the north, across the Border Ranges Fault (Johnson, this volume). Thus these plutons provide an important constraint on the time of last possible significant movement and terrane displacement.

PALEOMAGNETISM

As rocks cool, magnetic minerals have the tendency to record a dipole moment due to the Earth's magnetic field. Through demagnetization, the inclination of the magnetic pole can identified and used to calculate latitude of the body of rock being studied was formed (Tauxe, 2011).

In the laboratory, rocks can be demagnetized to better understand their primary magnetization by two methods: thermal or alternating frequency (AF) demagnetization. Thermal demagnetization involves the heating of rocks in intervals, or steps, and measuring the magnetic intensity once the step temperature has been reached. The unblocking temperature is the temperature at which the magnetic minerals lock in the dipole moment of the field they were formed in; this can either be the natural field (Earth's magnetic field) or some overprint. The second method of demagnetization, AF, involves subjecting a rotating sample to an increasing magnetic field. The field is measured in milliTeslas (mT) and is a description of strength relative to Earth's magnetic field. A strong enough field will act like the unblocking temperature showing an inclination possibly related to a characteristic remanant magnetization. AF demagnetization has an added advantage of identifying and removing chemical and thermal overprints (Tauxe, 2011). Through demagnetization the natural remanant magnetization (NRM), current magnetization of the sample, will be altered to reflect an overprint or the original magnetization. The original magnetization is referred to as the characteristic remanant magnetization (ChRM). Minerals can be remagnetized through different processes, deviating the NRM from the ChRM. In the CPW terrane, the two possible remagnetization events encountered are thermal remanant magnetization (TRM) and chemical remanant magnetizations (CRM). The ChRM is thermal event related to the crystallization and cooling at a spreading ridge, the ChRM can be altered from local events such as the emplacement of a pluton. The Eshamy suite of plutons intruding and associated hydrothermal processes provides the potential for TRM and CRM overprints. It is known that there was a significant thermal overprint of these rocks at 37-40Ma such that Tmax reached at least ~200°C (Carlson, this volume).

Sampling

Samples were collected from well-exposed tidal cut outcrops. Samples were drilled with a Pomeroy EZ Core Drill and oriented in the field with a Pomeroy orienting fixture and a Brunton compass. Orientation of the sheeted dikes was determined by identifying chilled margins. Samples were taken mainly from sheeted dikes found on the interior bays of the Knight Island (especially Drier Bay). In locations where dikes were not available, pillow basalt samples were collected to compare results from Bol (1993).

Fractured samples from the coring process were pieced back together in the lab using Ducco cement. Samples were cut to a 2.5 cm length using a table saw. Cores were able to provide two to three samples depending on length drilled in the field and thus over two hundred samples were prepared for demagnetization and analysis. In this contribution I report preliminary results of two sites from a total of 83 cores across 11 sites on Knight Island (Fig. 1).

Due to the weak magnetization of the samples and potential for overprint magnetizations, samples were demagnetized using AF rather than thermal. Samples were demagnetized using a 2GEnterprise Super Conducting Magnetometor at the University of New Mexico. A demagnetization process of 0 to 20mT at 2mT intervals and 20 to 89mT at 3mT intervals was used to demagnetize the samples. This detailed de-

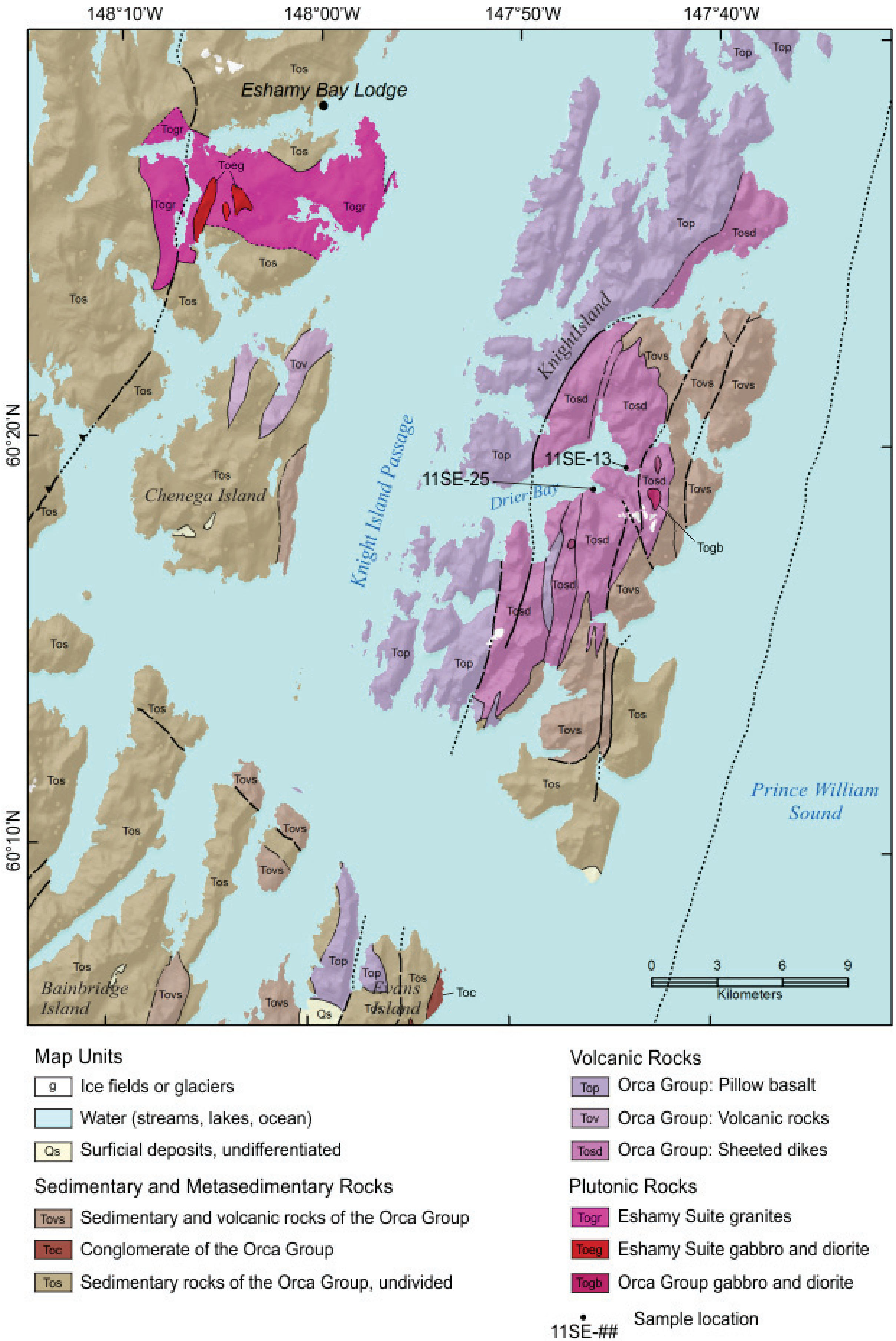

Figure 1. Geologic map of Knight Island ophiolite, Prince William Sound, Alaska.

magnetization process was chosen to attempt to wipe out overprints that were identified by Bol (1993).

Dikes are near vertical at all sample areas (Tbl. 1). Because of the relatively simple structural geometry of the sheeted dike complex, tilt corrections to bring samples back to paleohorizontal was straight forward and a fold test was unnecessary.

ANALYSIS

Demagnetization data are plotted on orthogonal graphs according to x1 versus x2 and H versus x3 (vertical) where H is the magnitude of the vector sum of x1 and x2 (Tauxe, 2011). As a sample demagnetizes, both plots should trend to the origin. The vector path to reach origin includes the inclination of the ChRM. In an ideal scenario samples will have a linear trend ending at the origin.

Out of 29 demagnetized samples, none plotted to the origin. A great circle was fit to end point members to the origin, providing a plane on which the inclination should lie within a margin of error (Tbl. 2). Great circles from a site were combined and analyzed with Fisher statistics (Fisher, 1953) to identify a mean declination and inclination with 95% confidence (Fig. 2).

Site	Strike/Dip
11SE-13	139/78, 170/80
11SE-25	107/82

Table 1. Dike orientations on Knight Island, Alaska.

Sample	*Dg*	*Ig*	*Dt*	*It*	*MAD*
13BA	187.5	71.3	216.7	-2.1	27.1
13BB	136.1	29.7	167.7	8.4	21.6
13EA	147.2	2.1	142.7	-7.6	9.5
13EC	162.9	5.5	150	-22	
25BB	209.7	-2	262.5	-76	35
25DA	58.7	-7.6	87.4	45.6	42.7
25EA	63.5	-36	58.6	25	17.4
25FA	42	-8.6	73.8	60.1	14.7

Table 2. Dg *declination before correction, Ig inclination before correction, Dt declination after tilt-correction, It inclination after tilt-correction,* MAD *maximum angle of deviation.*

DISCUSSION

From the samples run, only two sites: 13 and 25, provided demagnetization data suitable enough to analyze using great circle fits and Fisher statistics. Within both of these sites, at least one sample contained a declination and inclination very different from the other two (Tbl. 2). Samples having flipped inclinations within the same dike are evidence for folding or overprinting. Because these dikes are near vertical and have little evidence of folding these inclination changes interpreted to be related to overprinting. These inclination differences between sample localities (Tbl. 3) are consistent with prior observations of numerous overprint directions within Knight Island pillow basalts (Bol, 1993).

CONCLUSION

Paleomagnetism from the Knight Island ophiolite is in a unique position to clarify issues regarding the transport of the CPW terrane. However, the current small sample population of overprinted rocks has not been able to provide further insight into the distance and direction the Knight Island ophiolite has traveled to reach its current latitude. In addition, inclination change from down to up within the same dike is a

Sample	*N/n*	*Dg*	*Ig*	*Dt*	*It*	*a95*	*k*	*lith*
13	3 4	63.1	27.2	79	-12.6	43.3	4.1	d
25	3 4	324.2	-17.5	338.4	44.4	33.2	9.9	d

Table 3. Summary paleomagnetic data for the Knight Island ophiolite. N *is the number of samples used for mean inclination,* n *is the total number of samples processed for site. Declination* Dg *and inclination* Ig *are the best fit great circle before correction. Declination* Dt *and inclination It are the best fit great circle after tilt-correction. Alpha-95* a95 *confidence defines an area where true mean is contained within calculated mean using dispersion parameter* k *(Fisher, 1953). The lithology* lith *of the samples are either dike* d *or pillow basalts* b.

confirmation of overprinting. A larger data set will provide: a) more evidence for overprints b) evidence for a regional fold that needs to be applied for tilt correction of the dikes.

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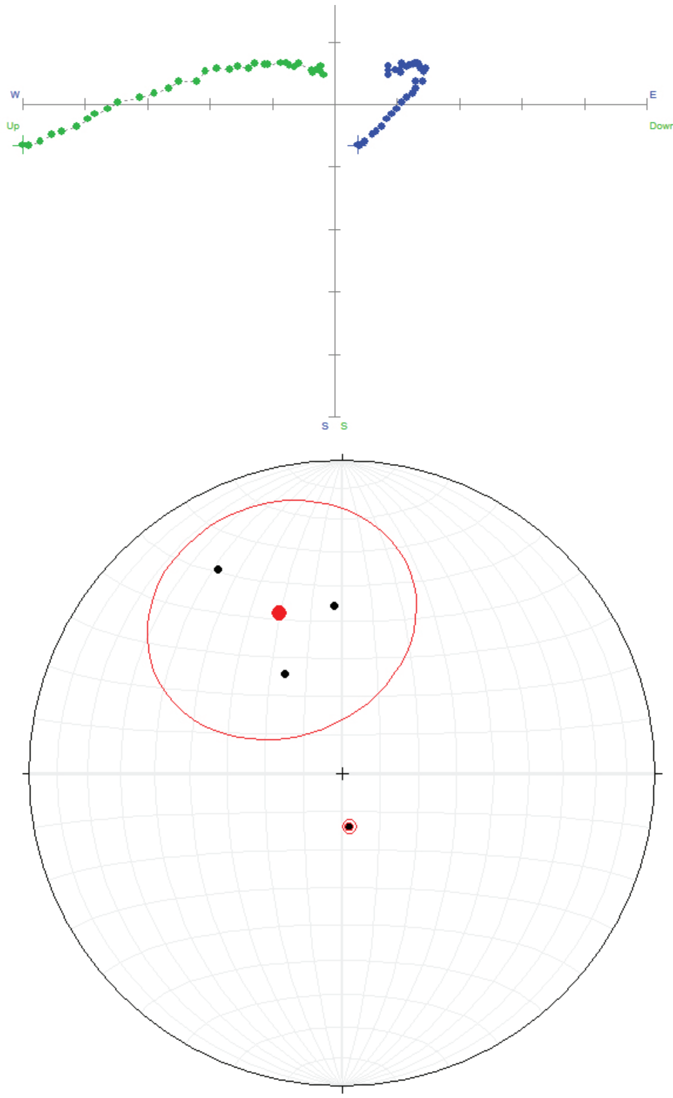

Figure 2. (A) Tilt-corrected orthogonal diagram for sample 25Bb. Blue dots are horizontal components, green are vertical components scaled at 13.3e-3 A/m. Note that the endpoints trend toward the origin but do not reach it. (B) Lower hemisphere stereonet projection of the poles to great circle fits (black dots) for three samples from site 25 (Fig. 1). Red dot is calculated vector mean from poles. The red region defines the 95% confidence of the calculated mean vector (Fisher, 1953).

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