Fabric of the Cascadia subduction zone just south of Point Delgada, California

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INTRODUCTION

This study describes both the lithologic and structural fabric of rocks deposited and deformed in part of the Cascadia subduction zone. It is part of a larger study by Merritts and Beutner of Franklin and Marshall College investigating both the nature of the Mendocino Triple Junction and the onshore termination of the San Andreas Fault in northern California. The Keck Foundation provided its funding during the summer of 1995.

The study area (Fig. 1) is located between Bear Harbor and North Whale Gulch, approximately 5 kilometers south of Point Delgada. The Cascadia subduction zone deposited the rocks of this area from early Jurassic to mid Miocene time, progressively scraping the subducting plate and transferring material to the continental plate as an accretionary wedge. Since the Miocene, the wedge has continued to suffer deformation possibly associated with the San Andreas Fault System.

Typical Cascadia subduction zone fabric is a chaotic, heterogeneous assemblage consisting of resistant blocks of greywacke floating in highly sheared shale, siltstone and graywacke masses.

Sequential strike and dip measurements along a coastal traverse (Fig. 2) define seven distinct packages of similar average bedrock orientations (Fig. 1). Deformation within the packages is commonly intense but average orientations remain relatively constant. Four of the packages have internal orientations sub-parallel to the coast with generally vertical to steep dips. These are interrupted by three other packages with orientations changing abruptly to N/NE strikes.

Older Fabric Elements

Some sections of Cascadia bedrock have olistrome-like depositional features reflecting a trench-slope environment distinguished by fluid-like structures. Flow bands and sand dikes are common as a result of de-watering processes.

Greywacke phacoids are the most distinctive structural features found in the packages. The phacoids are 10-40 cm long remnants of greywacke layers broken into discontinuous segments by persuasive extension and stretching mechanisms operating in a NW-SE direction, with phacoidal flattening sub-parallel to average bedding in the packages. Quartz and calcite rich extension veins trend NE, approximately perpendicular to the long dimensions of the phacoids.

These extension veins may be related to the older of two distinct vein families identified in the Cascadia fabric and illustrated in the Flat Rock case study (Fig. 3 and 4). These older veins are 0.2 to 2.5 cm thick and indicate a N10°-20°W extension regime. The Flat Rock case study shows similar small faults with mineralogies similar to the older veins, dexturally displacing and elongating argillite beds in a NW/SE direction (Fig. 3 and 4).

Axial plane orientations of minor folds are sub-parallel to average bedding of the packages and indicate a N30°E compressional regime, axes plunge 10-20°SE. Extension veins and phacoids are folded around most the hinges, but some similar veins also cross-cut the folds indicating that the final stages of NW-SE extension overlapped in time with the folding.

Three distinct families of faults were identified along this section of coastal bedrock (personal communication, Jim Heyes). The oldest are completely lithified, narrow brittle fracture zones, 1 centimeter or less in width. The fault planes have no preferred strike but all dip more than 45° with slickenlines trending in many directions. These faults probably formed within the Cascadia subduction zone as the accretionary wedge was being scraped and molded into shape.

Intermediate Age Fabric Elements

A younger set of veins cuts through both greywacke phacoids, argillite matrix, and folds. These differ from older veins in thickness (0.1 to 0.2 cm) and by having minimal amounts of mineralization. Mineralogical studies of the two vein families are in progress and suggest that the older veins are mostly quartz and calcite, whereas the younger veins have a large zeolite population. Their systematic orientation suggests a N80°E extensional regime. At Flat Rock, these veins sinistrally displace the older vein family (Fig. 4).

Second generation fault zones are 50 cm to 15 m wide and are marked by extensive brecciation and shearing. These zones strike NW and dip steeply to the NE/SW. Other workers of the Keck group have associated these zones with a possible large strike-slip fault that may exist through the two linear valleys that run parallel to this part of the coast. Both the younger veins and intermediate age fault orientations are permissive of the San Andreas stress system but no direct relationship is proven.

Young Fabric Elements

The most recent episode of faulting has given rise to a family of northwest striking, northeast dipping reverse fault zones ranging in thickness from less than 1 cm to 40 cm. Only minor displacement is associated with these faults and kinematic displacement indicators are difficult to find. These faults are very common and are easily identified by large amounts of fresh, gray clay gouge and breccia. They may be correlated with recent NE/SW compression causing continuing uplift of the King Range. Locally, small amounts of typical, young fault clay gouge are found on the older fault sets suggesting possible reactivation along these planes.

CONCLUSION

These lithologic and structural features give a general description of the Cascadia fabric. Future work on vein mineralogy and the lithologic and sedimentologic features could build on package subdivisions herein defined. The subduction zone's three-fold history (assembly phase, fracturing and veining stage, and a final stage of apparent compression and range uplift) may be correlated with major tectonic phases. Surprisingly, there is no clear-cut signature of San Andreas offset in the local fabric, but on a larger scale, the nature and timing of structures bounding the packages needs to be investigated. Among the most important questions remaining is whether small scale fabric structures in each package have been rotated along with the average bedding or whether their orientations been superimposed upon blocks that were already rotated.

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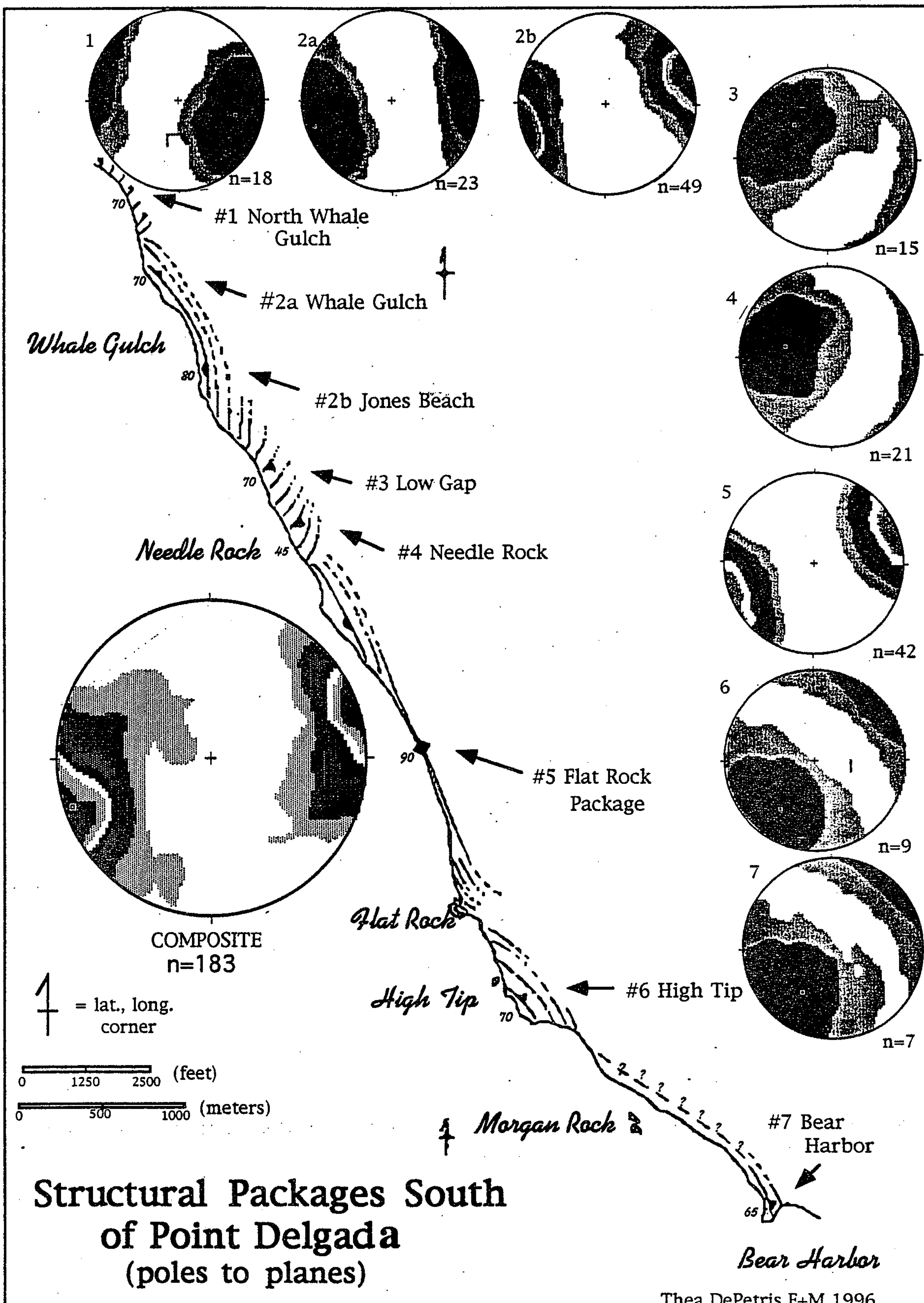

Figure 1. Coastal map of study area. General bedrock orientations of the seven packages are illustrated in the stereonet projections.

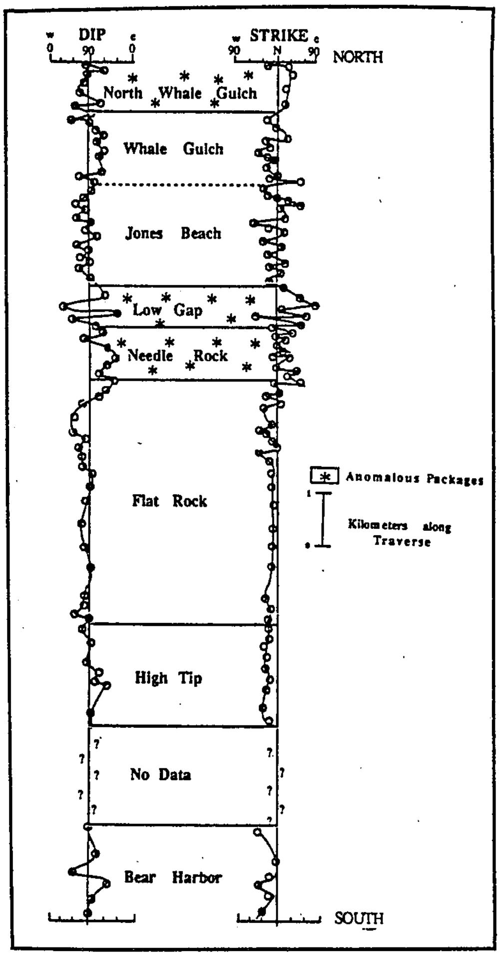

Figure 2. Strike and dip along a coastal traverse.

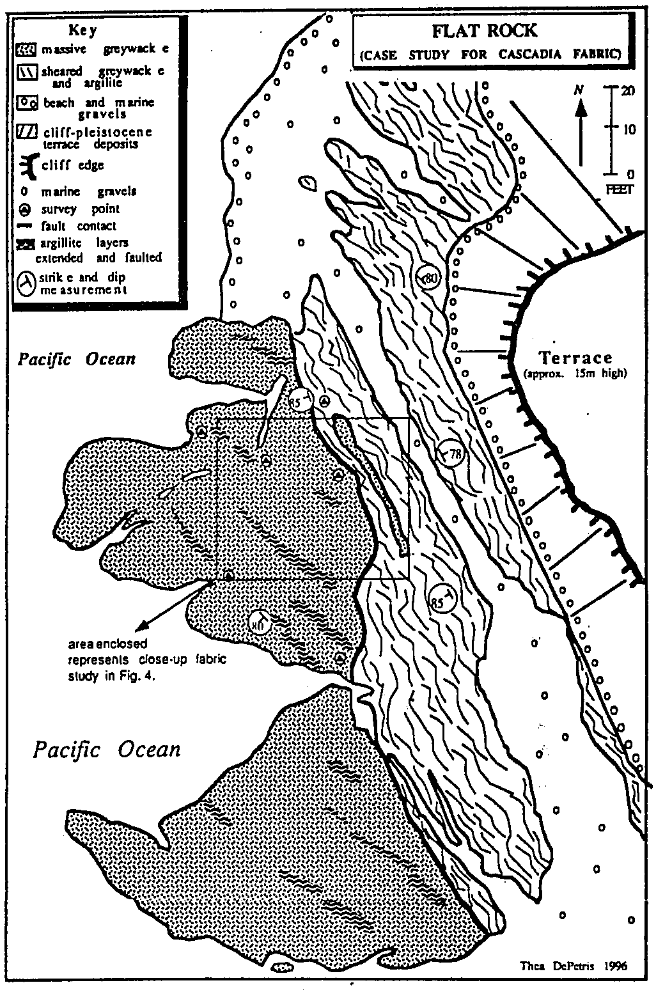

Figure 3. Flat Rock case study of Casdia fabric and small scale faults.

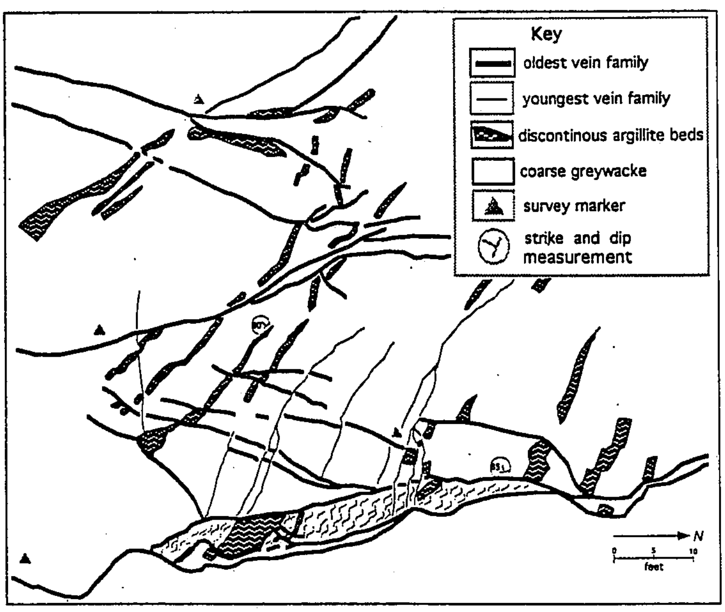

Figure 4. Illustration of fabric's two vein families and extended argillite beds, Flat Rock.