Geological studies in Cordillera Darwin, Tierra del Fuego, southern Chile: R/V *Hero* cruises 77-4 and 78-2

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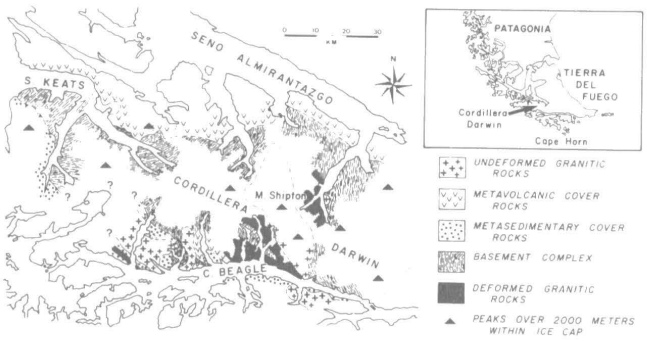
Cruise 77-4 of R/V *Hero*, in July 1977, marked the beginning of the first detailed geological study of the Cordillera Darwin massif in the Chilean Andes in almost 40 years—that is, since the study undertaken during the Finnish expedition of 1928-29 (Kranck, 1932).

This new study was continued during R/V *Hero* cruise 78-2 (May and June 1978). We collected detailed field data, mainly from excellent coastal exposures along nearly all the channels surrounding and penetrating Cordillera Darwin. Given the extent of the massif's ice cover, these exposures constitute a large proportion of the exposed rock in the cordillera (see accompanying map). In addition, we mapped the rocks and structures of Cordillera Darwin on a scale of 1:100,000, constructed numerous cross sections of the massif, and collected material for laboratory analysis.

One of the underlying reasons for our studies was that this region is of major importance in understanding the evolution of the southernmost Andes and, in turn, the Scotia Arc as a whole, in that the region exposes medium-grade (and, locally, high-grade) metamorphic rocks and extensive areas of pre-Middle or Upper Jurassic basement. In the southern Andes not only are these features unique but so are the intensity and complexity of the late Mesozoic "early Andean" strains displayed there. Geotectonically, Cordillera Darwin affords an unusual opportunity to study the deformation and metamorphism of terrain transitional between a marginal basin and the adjacent continental margin along a western Pacific type of convergent plate margin.

Prior to R/V *Hero* cruise 77-4, there were four major geological questions associated with Cordillera Darwin.



Geology of Cordillera Darwin.

As a result of our work, we are now in a position to supply answers. The questions and our answers are summarized below.

1. Do the so-called Central Schists of Cordillera Darwin mapped by Kranck (1932) represent deformed and metamorphosed upper Mesozoic cover rocks or do they actually represent older pre-Middle or Upper Jurassic basement?

The basement/cover unconformity previously recognized in Cordillera Darwin and elsewhere in the southern Andes was traced all along the northern margin of Cordillera Darwin. Lithologic correlation also permits its recognition in the southern part of the range, although there the contact is everywhere tectonized and the basal breccia of the cover sequence was not observed. Our nearly continuous mapping of the contact around Cordillera Darwin demonstrates that most of the Central Schists therefore represent reactivated pre-Middle or pre-Upper Jurassic basement rocks (see map).

2. What is the lithology of the basement rocks and what information can this provide concerning the early history of the southernmost Andes?

The basement complex consists of greenschist to amphibolite grade metamorphic rocks of variable lithologies, including pelitic and silicic phyllite and schist, metaquartzite and metachert, silicic metatuffs, and greenstones. Lithologic similarity between the basement and the metavolcanic and metasedimentary cover indicates comparable paleogeographic settings along the tectonically active Pacific margin of southern South America, both before and after the hiatus represented by the unconformity.

3. What is the basic geologic structure of Cordillera Darwin and how did it evolve?

Both basement and cover have been affected by at least two and possibly three phases of strong "early Andean" (i.e., mid-Cretaceous) deformation that generally obliterates any pre-Andean fabric within the basement. The reactivated basement rocks are exposed in the core of a horst-like structural culmination between northward-verging Andean folds in the north and southward verging Andean folds in the south, indicating that major crustal shortening has occurred in the area.

4. What are the field relations and significance of the granitoid rocks so conspicuous in the moraines around the cordillera and previously referred to in the literature as the Cordillera Darwin granites?

The granitoid rocks of Cordillera Darwin fall into two categories. First, there are tonalite and quartz monzonite plutons cutting the basement rocks that were themselves cut by a swarm of mafic sheets. These were deformed and metamorphosed together with the mafic sheets during the Andean orogeny to form a granitic gneiss-amphibolite complex. Second, there are posttectonic granitic intrusives that are most common in the central and southern parts of the cordillera and also form the highest peaks (see map).

In addition to providing bases for the above answers, our fieldwork also enabled us to make three other significant observations regarding Cordillera Darwin. First, the volcanic rocks of the cover in the south contain a significantly higher proportion of intermediate to mafic material than those in the north. Second, most of the basement complex and much of the lower cover se-

quence have been affected by low-grade (greenschist) recrystallization associated with the early Andean strains. The highest grade metamorphic rocks (upper amphibolite facies), and local migmatites, are found in close proximity to the early (pre-Andean) granitic rocks. Third, local growth of porphyroblastic minerals postdates early Andean (D_1 and D_2) structures, whereas metamorphism associated with the early granitic rocks must have predated the D_1 deformation. Thus, either the high-grade metamorphic history in Cordillera Darwin was long-lived or else there was a significant break in the thermal history.

Our work was begun in July 1977 (R/V *Hero* cruise 77-4) by R. Forsythe, E. Nelson, and T. Wilson (Lamont-Doherty Geological Observatory), together with F. Hervé and E. Valenzuela (University of Chile) and M. Suárez (Institute of Geological Investigations of Chile) (Nelson et al., 1977). It was continued during cruise 78-2 by the authors of this paper in conjunction with A. G. Milnes (the Swiss Federal Institute, Zurich), C. Mpodozis (University of Chile), R. Guzman (Institute of Geological Investigations of Chile), and L. Oviedo (University of Concepcion).

References

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