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FIELD OBSERVATIONS IN THE PATAGONIAN ANDES DURING THE PENGUIN 2000 CRUISE: SOME CONSIDERATIONS ABOUT THE GEOLOGIC SIGNIFICANCE OF PREVIOUSLY UNKNOWN LITHOLOGICAL UNITS

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INTRODUCTION

A 10 day cruise on the yacht Penguin, allowed observation of two cross sections of the Patagonian Batholith and of the country rocks of its eastern margin, from Fiordo Peel in the NE, to Estero Elias in the west, and from there to Paso Kirke in the SE (Fig. 1). The area is fully covered by the 1:1.000.000 Geological Map of Chile (1) and partially by more detailed studies near its southeastern end (2).

The purpose of this communication is to describe the lithologies and field relations observed, some previously unknown in the area, and to suggest some tectonic interpretations bearing on the geological development of the Patagonian Andes in this region.

THE PALEOZOIC BASEMENT

This unit was studied in the northeastern part of the area mainly in Fiordo Peel and Canal Smythe, in the southern part of the area. Although no critical evidence to support the assignment of any outcrop to the Paleozoic was seen, it was supposed that the observed poly-deformed and usually schistose rocks belong to this unit. On Peninsula Staines, an unconformity of the Jurassic silicic volcanic rocks over this unit is observed (2). The distribution of this unit in the studied area differs from the one depicted in the Geological Map of Chile.

Fiordo Peel

The basement rocks at Fiordo Peel consist of metasandstones, in places up to several metres thick, sandstone-pelite alternations, black pelites and carbonate rocks. Quartz segregations are common. The main foliation in these rocks is approximately N-S with high dips predominantly to the west. In some cases a second foliation S_2 is clearly observed. The foliation is cut by mafic dykes, some as wide as 10 m

Of particular interest is the presence of big bodies of limestone and dolomites, variably metamorphosed. The main outcrops are in the eastern end of Fiordo Andres, and on the eastern shore of Fiordo Peel, some kilometres south of Fiordo Calvo. In both localities, the limestones are intruded by granites of the Patagonian batholith, causing the formation of tremolite- and garnet-bearing marbles. The extent of the outcrops is not known, but they appear to be quite considerable. A continuous connection between the two outcrop areas could not be established.

As no massive carbonate rocks are known from the Meso-Cenozoic stratigraphic sequence in the region, we suppose that they might be equivalent of the Madre de Dios and Diego de Almagro carbonate rocks, which occur outboard of the western margin of the batholith.

Canal Smythe

The rocks in this area are mainly mylonites, with a strong NS to NW foliation, with dips to the W or SW. Lineations, not always visible, plunge steeply to the N. The lithologies are phyllites and metasandstones, in places with granitic rocks in elongated lenses or bands. Foliation-parallel and folded quartz veins are abundant. Basic and siliceous dykes are numerous; they usually cut across the foliation, although some are parallel to it.

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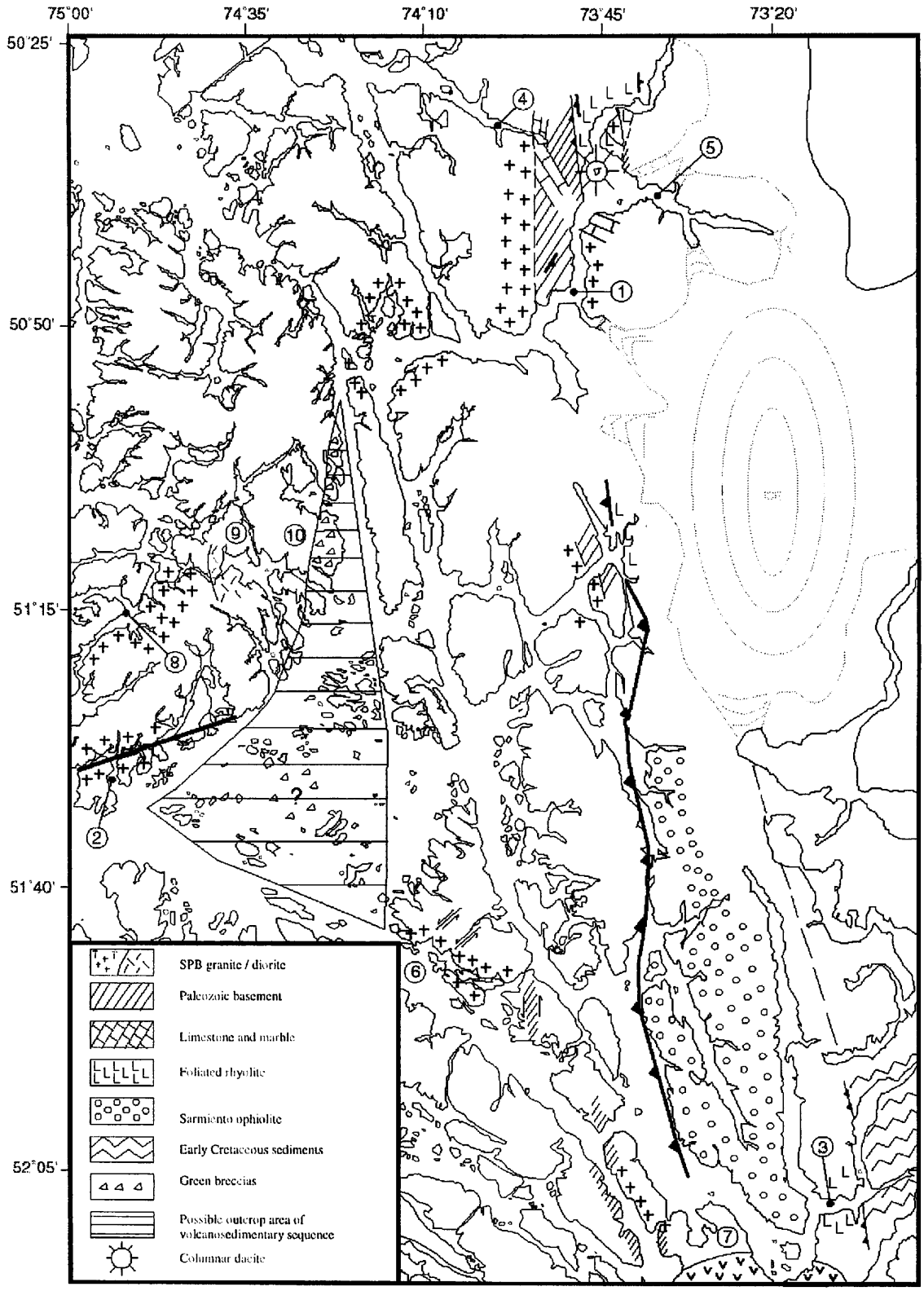

1 Fiordo Peel 2 Canal Elías 3 Paso Kirke 4 Fiordo Andrés 5 Fiordo Calvo 6 Canal Smythe 7 Península Muñoz Gamero 8 Canal San Blas 9 Canal Guadalupe 10 Isla Hannover SPB: South Patagonian Batholith

On the western coast of Peninsula Muñoz Gamero, the foliation is cleanly cross-cut by a coarse grained granitic body in an EW/45ºS direction. Some recrystallization is observed in the mylonites. The granite has a N70ºE cataclastic foliation.

The South Patagonian Batholith

The eastern contact of the Batholith is well exposed at two localities, in Fiordo Peel and in the northern shores of Isla Owen. Isotropic hornblende-biotite tonalite and leucogranite are in sharp contact with the metamorphic basement described above. The plutonic rocks contain a variable percentage of dark inclusions up to 0.5 m long and they are cut by a basic dyke swarm that dips gently to the SW. The contact is subparallel to the foliation of the basement, which is transformed into schist with abundant development of andalusite in narrow, decimetre-wide contact aureoles. The limestones are transformed into marbles, in which tremolite and garnet are observed.

Near its western margin, at Canal Elias, the batholith is represented by a tonalite-granodiorite complex with a gabbroic facies and frequent mafic inclusions. Approximately 10% of the outcrop consists of up to 10 m thick granite porphyry dykes with quartz and K-feldspar phenocrysts and a magmatic foliation. This pink granitic facies also forms bigger bodies, seen south of Canal Elias and particularly in Canal San Blas. Here, near the junction with Canal Guadalupe a sharp shallow dipping contact is seen with an amphibole diorite, which in turn forms wide tabular bodies within the granite. Mafic dykes form up to 5% of the igneous volume.

In the central part of the Batholith, on the southern coast of Isla Chatham, fine grained diorite and granodiorite crop out, dated at 20 Ma (hand written information on an unpublished geological map from ENAP) by previous authors crops out. These rocks are cut by thick mafic dykes with shallow dips to the E.

Foliated rhyolitic rocks of the Tobifera Formation

Well-dated Middle Jurassic (171.8±1.2Ma) (3) foliated rhyolitic rocks crop out at Canal Morla Vicuña. Foliation is planar and penetrative, and it strikes NS/70W. Abundant quartz and feldspar porphyroclasts are observed, as well as abundant quartz veins. Grey slate and volcanic breccia intercalations were observed within the rhyolites.

The rocks of the Tobifera Formation are overthrust to the East over a pelitic and sandy sequence which probably belongs to the Zapata Formation of Late Jurassic to Early Cretaceous age (2). This unit has tight folds of decimetric amplitude near the thrust, which become more open to the east. A NS/60W axial planar cleavage is present.

Similar but previously unmapped foliated rhyolites crop out on both shores of the northern end of Fiordo Peel, and at the entrance of Seno Exmouth. S-C structures were observed in some outcrops, with roughly NS/65ºE shear planes with strongly dipping SE directed lineation. Quartz and feldspar porphyroclasts are widespread, as well as abundant quartz veins. Amphibolitic gneiss bodies, probably mafic dykes originally, occur parallel to the shear planes.

A volcanosedimentary sequence

The eastern portion of islas Hannover and Gabriel Gonzalez Videla, are composed of a stratified sequence of green volcanic breccias and intercalated well bedded sandstones, cut by a mafic dyke swarm. A clast of diorite was observed in one of the breccias. Bedding is N60ºE/30ºS and dykes trend mainly N50ºE/90. This unit develops a subdued topography, and it probably underlies most of the complex archipelago made up of a large number of small and low islands which extend to the SE of Canal Castro. The green breccias were obviously visible from the boat along the traverse of this archipelago from Canal Guadalupe to Canal Smythe. The lithology and the field aspect of these rocks are strongly reminiscent of the Mid-Cenozoic Traiguen Formation of the Chonos Archipelago (4). Part of this outcrop is mapped as Tobifera Formation in the Geological Map of Chile.

The volcanic center of Isla del Medio

Isla del Medio, located at the intersection of Fiordo Peel and Seno Calvo, is composed of porphyritic dacite, with hornblende and plagioclase phenocrysts, and with well developed columnar jointing. Several bodies with different jointing directions and spacement were observed. The freshness of the volcanic rocks and their tectonically undisturbed condition, point towards a young age for this volcanic centre, which displays an exceptional rock type in the area. It is located 20 km to the west of the holocene Aguilera and Mano de Piedra volcanoes.

Some constrains on geologic evolution

A Paleozoic metamorphic basement is present in the area. It includes large masses of massive limestone, which in outcrop are similar to those of Madre de Dios and Diego de Almagro. If they are really equivalent, the allocthoneity of the latter has to be re-evaluated as the terrane limit would have to be located east of the Fiordo Peel area, and not restricted to the western archipelagos. Alternatively, the large limestone bodies might have been formed at or near the continental margin.

The roughly NS shear zones of Canal Smythe (CS), which affects basement rocks and of Canal Morla Vicuña (CMV)-Fiordo Exmouth (FE), which mainly affects Middle Jurassic rhyolitic rocks, developed before the intrusion of the Patagonian Batholith, which is seen to cut across the mylonitic foliation, and is not itself tectonically foliated. The tectonic event which generated the mylonitic foliation, has reactivated the metamorphic basement, producing the S_2 foliation exhibited in Fiordo Peel. This relationship, a foliation cutting accross the Paleozoic basement and affecting the Tobifera formation, is similar to the situation described in (2) at Peninsula Staines. The granitic lenses within the mylonitic rocks at Paso Palermo may either indicate the presence of older granitic rocks in the area, or a post-SPB reactivation of the shear zone.

This foliation is probably related to tectonism that accompanied the opening of the Sarmiento ophiolitic basin, which crops out between CMV and CS shear zones. It could thus be earlier that the thrusting of the CMV rhyolites over the Cretaceous sediments which crop out east of CMV into Paso Kirke, since the Early? Cretaceous sediments there develop only an axial planar cleavage in a folded sequence in which the beds maintain their stratal coherence.

The post batholithic structures are represented by a set of N60ºE directed sinistral brittle faults which affect the granitic rocks in the northern part of Canal Smythe and in Canal Elias. Cataclastic rock fabrics with crude foliation in this general direction were also observed at the contact between the batholith and the Paleozoic mylonitic basement at Isla Gonzalez Videla. They might be related to extension accompanying the volcanism which gave rise to the green breccias and mafic dyke swarms of the Canal Castro-Estrecho Esteban area, a sequence which is lithologically and structurally very similar to the mid-CenozoicTraiguen formation in the forearc of the Andes of Aysen.

Finally, the Isla del Medio volcanic centre, probably of Late Cenozoic age, could be interpreted as a forerunner of the Holocene volcanism of the Austral Volcanic Zone, and might thus indicate an eastward migration in time of the volcanic arc which at present lies some 20 km to the East. It will be of great interest to determine if these volcanic rocks, are also adakitic as are the holocene volcanic rocks (5), implying that slab melting events might have started before than thought up to now in this area.

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