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Recent Work on the Stratigraphy of Mesozoic Rocks in the Aysén Region, 44-47° S In Particular the Upper Jurassic Ibáñez Formation

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Introduction

The Eastern Aysén Region from 45°-47°S is characterised by Jurassic and Cretaceous silicic volcanic rocks and volcaniclastic terrestrial rocks, comprising two major formations separated by shallow marine and continental sediments. In the Puerto Ingeniero Ibáñez region, these rocks have been mapped at 1:50000 scale to discover new information on their stratigraphic relationships. Of the two volcanic Formations, the Late Jurassic Ibáñez Formation is dominated by thick tuffs and ignimbrites, and is more deformed, while the Lower Cretaceous Divisadero Formation is characterised by tuffs and tuffaceous floodplain sediments. The division between these two volcanic Formations is the Coyhaique Group, of Lower Cretaceous marine black shales and tidal sandstones. This sequence is cut by both hypabyssal volcanic rocks and outlying stocks of granitic rocks associated with the Patagonian Batholith.

Geological Setting

Mid and Upper Jurassic silicic volcanic rocks, locally named the Ibáñez Formation[1,2] overlie Palaeozoic semi-pelitic schists. Within the area mapped in the summer 1995-96, the Palaeozoic schist basement does not occur as outcrop, but is common as lithic fragments in some of the ignimbrites, and as large xenoliths in one of the minor intrusive bodies. The Ibáñez Formation is at least 1000 m thick, and consists of a faulted sequence of rhyolitic and dacitic domes, tuffs and ignimbrites, with some andesitic lavas and pyroclastic rocks, intercalated with continental lacustrine and fluvial sediments and minor marine incursions in the upper part of the unit[3]. This Formation has been variously ascribed to subduction related volcanism[4,5] or grouped with the large Chon-Aike / Marifil / Tobifera silicic province, suggested to be due to large scale crustal anatexis during the rifting precursor phase of Gondwana separation[6,7].

Unconformably overlying the Jurassic igneous rocks is a transgressive - regressive sequence, the Lower Cretaceous Coyhaique Group of shallow marine rocks forming the northern expression of the Austral Basin[8]. This Group consists of discontinuous limestones, tuffs and fossiliferous sandstones (Toqui Formation), overlain conformably by a thick (up to 600m,) extensive unit of fossiliferous black shales (Katterfeld Formation), which in turn grades abruptly into the Apeleg Formation, a homogenous unit of ripple and trough crossbedded sub-tidal (and locally deltaic) shallow marine sandstones[9,10].

Overlying the Coyhaique Group are the volcaniclastic rocks of the Divisadero Formation, a Lower Cretaceous silicic volcanic unit with flood-plain deposits and some deltaic facies, together with widespread tuffs, ignimbrites, and remnant rhyolitic, dacitic and andesitic eruptive centres[2]. Above the

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Divisadero Formation are patches of Late Cretaceous and Tertiary flood basalts, including some possible eruptive centres.

The entire sequence is cut by several generations of intrusives, both the Mid-Cretaceous to Miocene granitoids of the main Patagonian Batholith to the west, and numerous local hypabyssal intrusives and dikes ranging from the Jurassic through to Tertiary and Recent. Active volcanism in the region is represented by Volcan Hudson, and there is also evidence of basaltic pyroclastic rocks and subglacial pillow lavas during the last glaciation (Belmar, pers. comm. 1995)

Jurassic Stratigraphy

Within the area studied, the Ibáñez Formation is dominated by silicic volcanic rocks, mainly tuffs and ignimbrites. Extrusive lavas are less common, but areas of dacitic to rhyolitic lavas and domes occur, as do minor andesitic lavas and pyroclastic rocks. Cutting the Formation are large numbers of minor normal and some reverse faults, which make correlation of individual units difficult. In the Rio Ibáñez valley itself, many of these faults show a strong south-east to north-west alignment, and slickensides indicate both vertical and sub-horizontal movements. Ignimbrites in this area are generally five to twenty metres thick, although some show ponding up to 100 metres. Most are massive units, with simple cooling features, and columnar jointing is rare. From the lack of columnar jointing and the poor preservation of microscopic shard textures, it is difficult to distinguish primary welding from diagenetic features. In the lower parts of the exposed sequence, an ignimbrite with unaltered biotite has yielded a K-Ar age of 150 million years[11]. Intercalated with the tuffs and ignimbrites are sedimentary units, including fluvial deposits, mass flow deposits and laminated pelites. These sediments are occasionally fossiliferous, but contain only wood fragments, leaves and trace fossils, and as yet no body fossils have been found. In several places around Puerto Ibáñez, large ignimbrite units are absent, and the formation consists of silicic lavas, breccias, tuffs and other volcaniclastic units, some of which are block and ash deposits directly associated with remnant dacitic and rhyolitic domes. Towards the upper part of the sequence, and locally just below the contact with the Coyhaique Group, Ibáñez Formation tuffs and thin ignimbrites are weathered to a distinctive purple clay, and are associated with remnant fluvial gravels. Associated with this apparent palaeotopography are isolated occurrences of aa andesitic lavas and some pyroclastics, infilling valleys eroded into older silicic Ibáñez rocks.

Upper Jurassic-Lower Cretaceous Stratigraphy

The base of the Coyhaique Group to the north-east of Puerto Ibáñez is poorly exposed, and in places disrupted by later Cretaceous and perhaps Tertiary intrusives. Between Cerro Piramide and Cerro Farellon, the first indications of the Coyhaique Group are outcrops of black shales of the Katterfeld Formation. The base is not well exposed, and the shale has been disrupted by several different intrusions. Black shales outcrop over a large area between the two mountains, and are perhaps up to five hundred metres thick. However, further to the east at Cerro Cabeza Blanca, near the border with Argentina, the Katterfeld Formation is very thin or not present, and the overlying Apeleg Formation displays onlap relationships to the weathered paleotopography of the Ibáñez Formation. Locally, the Katterfeld Formation is responsible for landsliding that repeats some stratigraphy of the Apeleg Formation. The shales are fossiliferous in places, with ?Crioceratites Ammonoid species, Ostrea fragments, Bivalves, bone fragments and shark teeth. At its upper contact the Katterfeld Formation grades abruptly into thickly bedded Apeleg Formation.

The Apeleg Formation to the north-east of Cerro Piramide displays foreset crossbedding, fining upward sequences, and grades upwards into continental

redbeds of the Divisadero Formation, with channels and algal limestone fragments. The sandstones are 100 to 120 metres thick, with individual beds up to three metres thick, dominated by coarse and very coarse sands and fine gravels but varying to rippled fine sands and some shales. The upper part of the underlying Katterfeld Formation rapidly coarsens upward from carbonaceous mudstones, shales and siltstones, through fine sandstones to Apeleg Formation thickly bedded coarse sands, which then display two fining upward sequences, the upper of which grades into the overlying Lower Divisadero Formation redbeds. The upper parts of the Apeleg Formation and lower parts of the Divisadero Formation redbeds have both carbonised and petrified tree trunks, but not in life position.

The Divisadero Formation crops out in the north-east of the area mapped, and is dominated by tuffs and tuffaceous sandstones. It is preceded by the deltaic transition from Apeleg Formation to Divisadero Formation continental redbeds. The redbeds in places grade into the overlying tuffs and ignimbrites of the Divisadero Formation proper, but in at least one location the contact with the Divisadero is paraconformable, (truncated dike at Cerro Cabeza Blanca.) Ignimbrites are less common than in the Ibáñez Formation, and generally less altered. Some still display deformed glass shard textures, but there are fewer welded, columnar, or complexly stratified ignimbrites. A significant feature of this Formation are the common, well preserved accretionary lapilli that occur in the tuffs. Channel structures and conglomerates occur, notably in the redbeds at the base of the formation, but can also occur at higher levels. As with the Coyhaique Group, between Cerro Farellon and Cerro Piramide, the Divisadero Formation is locally deformed and cut by later intrusive rocks. There are significantly fewer faults displacing the Cretaceous rocks, as compared with the densely faulted Ibáñez Formation. However, what faults do occur have significant displacements. West of Cerro Piramide, Rocks of the Ibáñez Formation are reverse faulted over the Divisadero Formation by a minimum of five hundred metres, whereas within the Divisadero, discrete normal and reverse faults occur, but without the dense faulting of the Jurassic rocks. Although dominated by tuffs and tuffaceous sediments in this area, in the upper exposure of the Divisadero Formation at Cerro Pico Rojo there is a remnant peralkaline rhyolite dome which retains parts of coulee flows and small pumice flows.

Intrusive Rocks

Intrusive rocks occur throughout the sequence, and in many cases are the least altered rocks available for analysis. There are two groups, microgranitoids and hypabyssal intrusives. The microgranitoids are of dioritic to granodioritic compositions and outcrop as irregular stocks and arcuate bodies. Some maintain granitic textures, but others grade into fine grained hypabyssal rocks. All have had moderate thermal metamorphic effects on the country rock, with contact aureoles ranging from a few tens of metres to perhaps a hundred metres wide. Small epithermal Pb/Zn/Cu-quartz veins and mineralised breccias occur within the contact aureoles of these rocks. The hypabyssal rocks are dikes, sills and irregular stocks, of compositions ranging through basaltic to rhyolitic, and including some trachytic rocks. Some sills are able to be traced up to three kilometres. The densely faulted Ibáñez Formation is host to the majority of dikes, some of which are coeval with Jurassic activity, but many of which post-date it. Breccia pipes are also present. These minor intrusive rocks are difficult to separate into distinct age groups, and represent the combined subvolcanic intrusives from the Jurassic to Tertiary. Many of the dikes within the Ibáñez Formation are cut by the faults confined to the Ibáñez Formation, and can be tentatively assigned to the Late Jurassic. This includes dikes, sills and stocks of andesitic, trachytic and rhyolitic compositions, ranging from dikes and sills a metre thick to bodies up to several hundred metres across. Several of the intermediate sized intrusions up to a kilometre across,

of trachytic and basaltic compositions, cut all rocks up to the Divisadero Formation, and so can be assigned ages of Mid Cretaceous or younger. The larger granodioritic intrusions also cut the sequence up to and including the Divisadero Formation, and can also be assigned to the Mid Cretaceous or Tertiary.

Discussion and Conclusions

As both fieldwork and analysis are still in progress, any regional synthesis is premature. However, the following tentative conclusions can be put forward:

1) The Ibáñez Formation has physical characteristics consistent with a large rhyolitic province, with an area of approximately 14,000 square kilometres. Ignimbrite outflow sheets and tuffs are intercalated with fluvial and possibly lacustrine sediments, and occasionally with dacitic and rhyolitic domes, breccias and associated pyroclastic rocks. Andesitic rocks occur more towards the upper part of the sequence. Faulting of the sequence makes exact stratigraphic correlation difficult.

2) The upper parts of the Ibáñez Formation show significant weathering and paleotopography varying as much as 600 metres, as can be estimated from the changes in thickness of the overlying Katterfeld Formation of the Coyhaique Group, and the onlap relationships the Coyhaique group rocks display towards the upper Ibáñez paleotopography.

3) The occurrences of the Coyhaique Group and Divisadero formation are consistent with the marine transgressive-regressive sequence and prograding volcaniclastic deltaic interpretations given to them by previous workers.

4) Although both the Ibáñez and Divisadero Formations in this locality are deformed, the Ibáñez Formation shows a much greater density of faults than the overlying rocks.

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