THE BASEMENT ROCKS OF PENINSULA STAINES, REGION XII, PROVINCE OF ULTIMA ESPERANZA, CHILE

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RESUMEN

En el área oriental de la península Staines se presenta, muy bien expuesta, una discordancia angular que separa una cubierta volcano-sedimentaria de un complejo del "basamento" con deformación múltiple. Los estratos de la cobertura, que se correlacionan con la Formación Tobífera, están compuestos por rocas volcánicas síliceas interestratificadas con sedimentos volcanoclásticos. El complejo del "basamento", que es una parte integral del basamento pre-Jurásico Superior de la cordillera magallánica, está compuesto, en este sector, por delgadas capas de cuarcitas, metareniscas, metapelitas y esquistos verdes. Posiblemente, representan litologías originales de cherts (con niveles bien estratificados), sedimentos flyschoides y basaltos.

Las relaciones estructurales entre la cobertura y el basamento indican tres fases de deformación regional. Las dos primeras ocurrieron con anterioridad al alzamiento y peneplanización del basamento, mientras que la tercera fase afectó tanto al basamento como a la cubierta volcano-sedimentaria del Jurásico Superior-Cretácico Inferior. La primera fase de deformación impone elementos de fábrica oblicuos a la Cordillera, en tanto que la segunda y tercera tienen, generalmente, fábricas con rumbos norte-sur.

Las observaciones estructurales y litológicas, realizadas en esta región, apoyan las correlaciones de este basamento con las secuencias del Paleozoico Superior en el archipiélago Madre de Dios y con los complejos del basamento expuestos más al norte, en el canal Baker, Puerto Aisén y Archipiélago de Las Guaitecas.

ABSTRACT

A beatifully exposed angular unconformity in the eastern isthmus area of Peninsula Staines separates an overlying volcanic/sedimentary cover from an underlying polyphase deformed basement complex. The cover strata, correlative with the Tobifera Formation, are here composed of silicic volcanics mixed within volcaniclastic sedimentary rocks. The basement complex, forming an integral part of the "pre-Upper Jurassic basement" of the southernmost Andes, is composed here of a) thinly banded quartzites, b) meta-arenites and metapelites, and c) greenschists. Feasible protoliths for these rock types are a) bedded chert, b) flysch-like sediments, and c) basalts.

Cover basement structural relations indicate three phases of regional deformation. The first two phases occurred prior to uplift and peneplanation of the basement, while the third phase involved both the basement and its (?) Upper Jurassic-Lower Cretaceous volcanic and sedimentary cover. While the first phase of deformation imposed fabric elements oblique to the present cordilleran trend, the second and third phase generally have consistent north-south directions.

Both lithologic and structural observations support the correlation of this basement with the Upper Paleozoic complexes in the Madre de Dios Archipelago as well as those exposed to the north in the regions of Canal Baker, Puerto Aisen, and the Guaiteca Archipelago.

INTRODUCCION

Peninsula Staines, located in Chile at 51°40'S and 73°40'W, in Region XII west of Puerto Natales (Fig. 1), contains excellent exposures of a metamorphic, polyphase deformed, pre-(?)Upper Juras-

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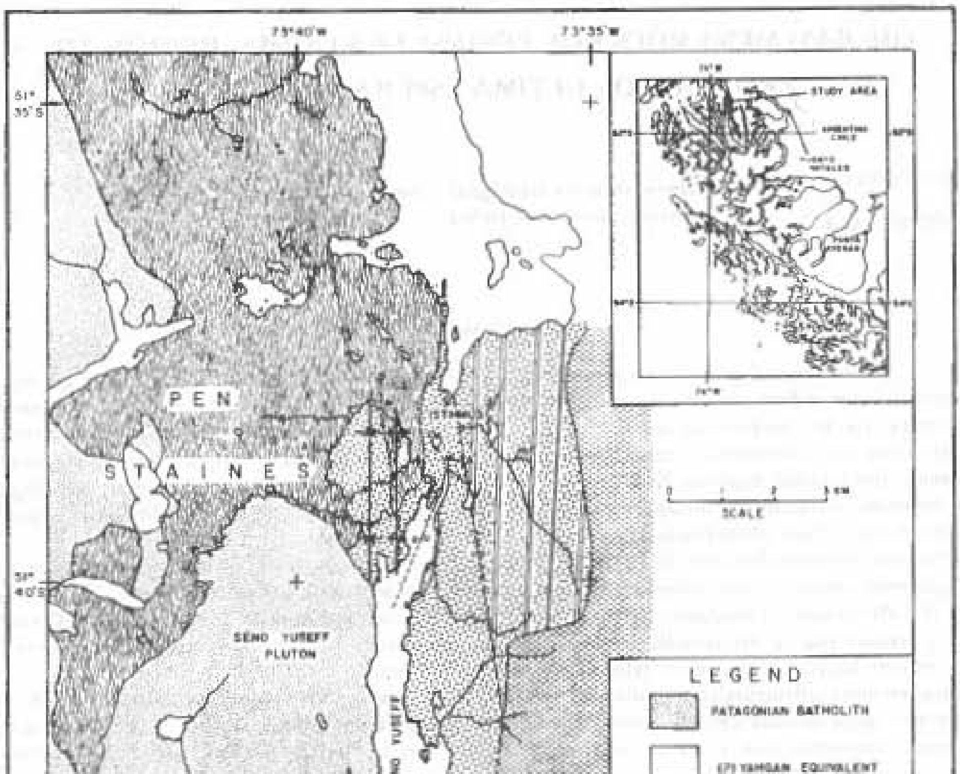
73°40'W
73°35'W
51° 35'S
51° 40'S
51° 45'S
PEN
STAINES
SENO YUSEFF PLUTON
SENO YUSEFF
BAHIA STEWART
STUDY AREA
ARGENTINA
CHILE
PUERTO NATALES
PUNTA ARENAS
SCALE
LEGEND
PATAGONIAN BATHOLITH
(?) YAHGAN EQUIVALENT
SARMIENTO COMPLEX EXTRUSIVES / DIKES
TOBIFERA FORMATION
BASEMENT OF THE 'STAINES COMPLEX'
GREENSTONE/METACHERT WITHIN BASEMENT
FAULT (inferred)
SYNCLINE
ANTICLINE

FIGURE 1

sic basement complex. Moreover, the surface of the angular unconformity that separates this basement from its Jurassic and younger cover strata can be studied over an area of several square kilometers within the Peninsula Staines isthmus zone.

Although previous authors (Cortés and Dalziel, 1970; Dalziel, 1970; Stewart *et al.*, unpublished report of the Instituto de Investigaciones Geológicas, 1971; Dalziel and Cortés, 1972; Dalziel and Elliot, 1973; Dalziel, 1975; Bruhn *et al.*, 1978) have reported and commented on the presence of this unconformity, we report the first detailed study of the basement rocks, with particular emphasis on the lithology, internal structure, and relation to cover strata.

REGIONAL SETTING OF THE BASEMENT

The basement outcrops of Peninsula Staines are part of a narrow zone of the pre-(?)Upper Jurassic basement exposed between plutons of the Patagonian batholith to the west and the belt of ophiolitic assemblages, forming part of the floor of the "Rocas Verdes" marginal basin, to the east Dalziel *et al.*, 1974). Within this zone the basement is exposed in three areas: on Peninsula Staines just west of the istmus, on Peninsula Staines further to the south and separated from the first exposure by a younger pluton, and along the northeast coast of Seno Yuseff. (see Fig. 1).

West of the isthmus of Peninsula Staines (see Fig. 1), the basement complex is overlain with angular unconformity by silicic volcanics and volcaniclastic sedimentary rocks correlated on lithologic and regional grounds with the Tobifera Formation (Cortés and Dalziel, 1970; Stewart *et al.*, 1971; Bruhn *et al.*, 1978), and hence probably of Upper Jurassic age. The basement exposed in the immediate vicinity of the isthmus is intruded to the west and south by plutons of the Patagonian batholith, that to the south being called here the Seno Yuseff pluton.

The southern basement exposure is bounded to the north by the Seno Yuseff granitic intrusive body and to the west by other plutons of the Patagonian batholith. To the east the rocks of this southern basement outcrop are in fault contact with well bedded volcaniclastic sedimentary rocks, which are correlated on lithologic grounds with the Lower Cretaceous Yahgan Formation (Katz and Watters, 1966), though admittedly lacking fossils.

To the east of Peninsula Staines, basement is exposed only within a small coastal fringe along the northeast shore of Seno Yuseff, where it is also overlain with angular unconformity by the probable equivalent of the Tobifera Formation. This represents the easternmost exposure of basement in the Cordillera at this latitude, though to the north and south limited basement exposures are found further east. The cover sedimentary rocks east of the isthmus are complexly bounded by mafic igneous rocks of the Sarmiento Complex. The Sarmiento Complex is the major body in this area of a north-south belt of mafic igneous rocks which constitute part of the floor of the Rocas Verdes marginal basin (Dalziel *et al.*, 1974).

COVER SEQUENCES

A basal breccia is locally developed above the irregularly eroded basement surface. This breccia is composed chiefly of subangular to angular blocks of basement, locally over one meter in diameter, in a finer clastic matrix. Overlying this are well bedded sedimentary rocks, ranging from fine silicic clastics to coarse conglomerates, as well as extensive ignimbrites, and rhyolitic flows and breccias. Stratigraphic relations between the various rock types are complex, with marked facies changes both laterally and vertically and extensive channeling. In places there is also evidence of soft sediment deformation.

To the east, the Tobifera Formation is in contact with mafic rocks of the Sarmiento Complex. Although locally mafic intrusives which may be related to the Sarmiento Complex cut the Tobifera, the exact nature of the boundary needs further study. Immediately south of the area covered in this report, intercalated mafic and silicic volcanics and sediments may indicate that activity related to the Sarmiento Complex was in part contemporaneous with deposition of the Tobifera Formation. Relations in other nearby parts of the complex, where probable Tobifera occurs as remnant screens heavily intruded by mafic dikes of the ophiolite, would seem to indicate, however, that the Tobifera largely predates the ophiolite (Allen and Forsythe, unpub. data). Because the basement predates the Tobifera, and thus probably the Sarmiento Complex, it is presumably cut at depth by the plutonic levels of the Sarmiento Complex.

Deformation of the cover sequence near the isthmus is shown by large scale open to tight folding of the unconformity surface as well as the overlying strata. This phase of folding is accompanied by the development of a penetrative cleavage in the Tobifera that is subparallel to the axial planes of the large scale folds (see cross section A-A', figure 2; and Dalziel and Cortés, 1972, plate 2 for photo of cleavage). The north-south orientation of these structures suggests that they are related to deformation of the Sarmiento Complex and the uplift and destruction of the Rocas Verdes marginal basin. These probably occurred in the mid-Cretaceous following arguments outlined by other workers (Dalziel *et al.*, 1974; Bruhn and Dalziel, 1977).

The well bedded sedimentary rocks in fault contact with the basement south of the Seno Yuseff pluton are grey volcaniclastic flysch-like sequences, which in this area contain distinctive calcareous lenses and pods. These sedimentary rocks are not polyphase deformed and are lithologically identical to sedimentary rocks elsewhere observed to be directly overlying the mafic volcanics of the nearby Sarmiento Complex (Allen, unpub. data). The sedimentary rocks are in turn lithologically similar to those of the Lower Cretaceous Yahgan Formation (Kranck, 1932; Katz and Watters, 1966), which appear to overlie units of the Rocas Verdes marginal basin further to the south (Dalziel *et al.*, 1974; Suárez and Pettigrew, 1976; Winn, 1978). Hence, the sedimentary rocks in fault contact with the basement are tentatively correlated with the Yahgan Formation. Adjacent to the fault, these rocks are upward facing, with bedding striking subparallel to the fault and dipping to the west. The actual fault, marked by extensive localized fracturing of both the probable Yahgan equivalent and the basement, is a high angle reverse fault, dipping west and striking northeast. The basement to the west is upthrown relative to the cover strata to the east.

The basement, the Tobifera Formation, and the strata probably equivalent to the Yahgan Formation, as well as all penetrative structures in these sequences, are cut by the intrusive contact of the Seno Yuseff pluton. Near the pluton all rocks are affected by a hornfels zone locally up to a few hundred meters wide. A whole rocks Rb/Sr isochron of 45 ± 6 m.y. has been obtained for the Seno Yuseff pluton in the vicinity of the Seno Yuseff coast (Halpern, 1973, locality 8) From this date, it would appear that a minimun age for the deformation seen in the cover strata here is 45 ± 6 m.y. As previously mentioned, regional considerations indicate the deformation took place in the mid-Cretaceous.

BASEMENT

The polyphase deformed rocks that crop out along the eastern limits of Peninsula Staines have been included within the pre-(?)Upper Jurassic basement of the southernmost Andes based on the regional correlation of the unconformity, and fossils discovered within the cover strata elsewhere (Cortés and Dalziel, 1970; Dalziel and Cortés, 1972; Stewart *et al.*, unpublished report). The unpublished report of Stewart *et al.*, (1971) referred to the basement in the vicinity of Peninsula Staines as the Staines Formation. However, because the degree of deformation and metamorphism has obscured original stratigraphic relations, and also because the basement includes lithologies which are of doubtful original stratigraphic continuity, the term Staines Complex is preferred here, and is taken to include all rocks beneath the unconformity within the Peninsula Staines area. The main outcrops of this complex are illustrated on the accompanying geologic map (Fig. 1).

PHOTO 1: UNCONFORMITY TRUNCATING S_1 & S_2

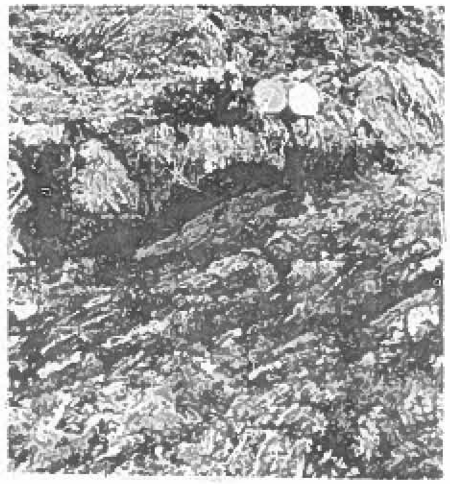

PHOTO 2: D_3 BRECCIA ZONE.

PHOTO 3: D_2 'PERVASIVE' QUARTZ VEINS.

PHOTO 4: BASEMENT BLOCK IN BASAL TOBIFERA WITH DISORIENTED S_0, S_1, & S_2.

PHOTO 5: METACHERT & D_2 FOLD.

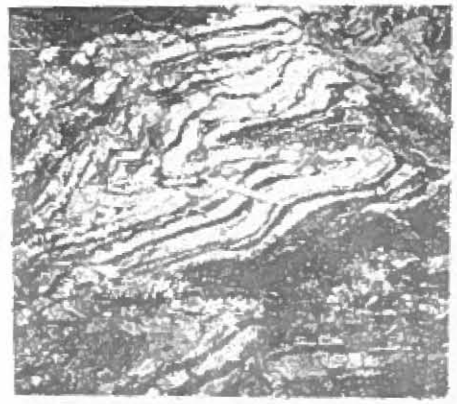

PHOTO 6: D_2 REFOLDING OF D_1 FOLD.

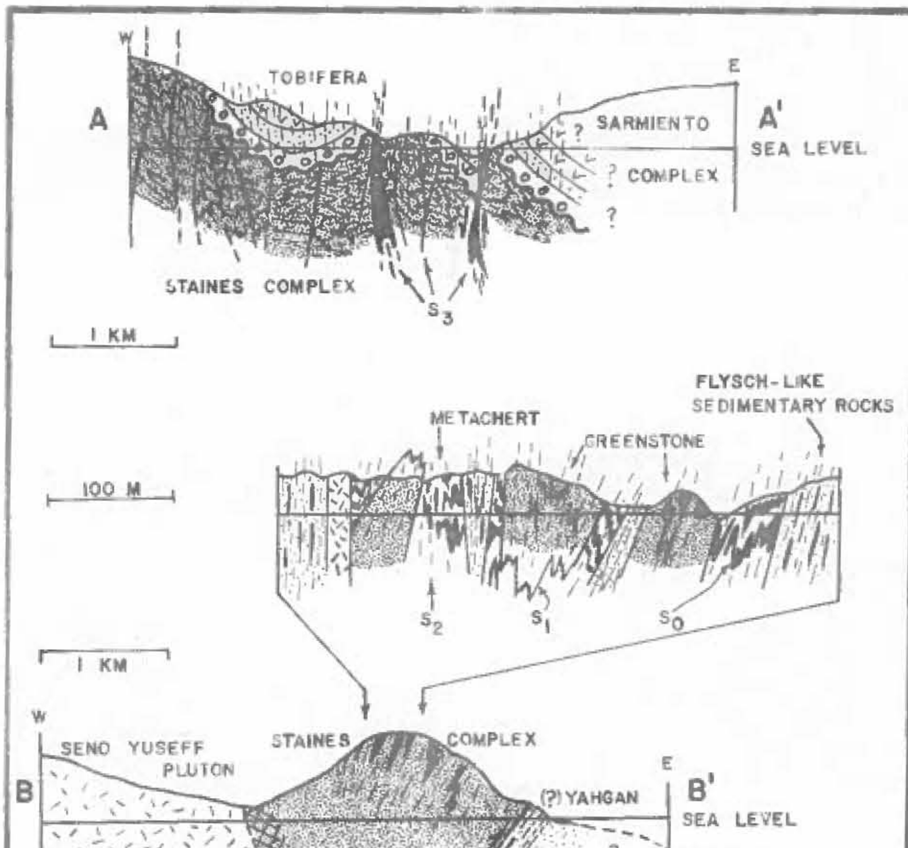

FIGURE 2

A. LITHOLOGIC UNITS OF THE STAINES COMPLEX

Along the east central portions of Peninsula Staines the complex is predominantly composed of an alternating sequence of metamorphosed sandstone, siltstone, and shale (as previously noted by Stewart *et al.*, unpublished report). This metasedimentary unit, forming perhaps 80 to 90% of the basement terrane, has a variable metamorphic grade and degree of structural transposition. Where the metamorphism and transposition are least intense an original graded detrital character is preserved in some of the coarser units. In thin section, the metasandstones are composed of 40 to 50% fine recrystallized groundmass within which some relic clastic texture is visible in addition to well preserved subangular lithic, feldspar, and quartz grains. However the abundance of orthomatrix present and the difficulty in separating polycrystalline quartz lithic fragments from polygonized quartz grains, makes classification of these metasandstones difficult. The relative abundance of feldspar and lithic clasts versus quartz clasts however, does suggest a subquartzose protolith (Dickinson, 1970). The poorly sorted subangular grains further suggest derivation of these sandstones from a tectonically active, or at least unstable source terrane.

In addition there exist distinctive lenses of rhythmically alternating quartzite and argillite beds, occasionally reddish in color, which occur almost randomly within the flysch-like sequences. The quartzite in these lenses was suggested to be metachert by Dalziel and others (1975). In the basement terrane exposed directly to the south of the Seno Yuseff pluton similar units of "metachert" are found intimately inter-foliated with chlorite/actinolite greenschists and gneisses. The rhythmic bedding and reddish color are identical to those of cherts within adjacent basement terranes in southernmost Chile that are also associated with greenstone (Dalziel *et al.*, 1975; Forsythe, 1978; Forsythe and Mpodozis, 1979). Thus the metacherts interpretation seems quite reasonable and will be accepted here. The individual beds of both quartzite and argillite range in thickness from 1 to 5 cm (see for example photo 5). In thin section the individual metachert layers seem to be composed of layers of polygonized quartz and are separated by layers of muscovite and sericite. The long dimension of the phyllosilicate minerals is usually subparallel to the compositional layering, and in hand specimen accounts for a bedding plane or compositional layering fissility. In outcrop the lenses containing metachert are usually a few meters across and up to a few hundred meters in length, however, in the zone to the south of the Seno Yuseff pluton they form lenses that when taken together with the associated greenschists and gneisses are up to several hundred meters wide and a few kilometers in length. The dimension of these larger lenses are approximated on the geologic map, and are illustrated in cross section B-B'.

The greenstones and gneisses which form the third basic unit of the Staines Complex are, as mentioned above, exposed only to the south of the Seno Yuseff pluton and are intimately interfoliated with the metachert units. In thin section these rocks display no primary mineralogy or structure, and are predominantly (70% - 80%) composed of radiating splays and mats of actinolite needles. The remaining portion is composed of quartz and feldspar and minor sphene and opaques. The ubiquitous occurrence of the greenstones with the metachert suggests an original submarine volcanic origin for the greenstones.

The three basic units, the flysch-like assemblage, the metacherts, and the greenstones, are now complexly transposed and interfoliated. While no stratigraphic relations can be observed, the intimate association of the metacherts with the greenstones to the south of the Seno Yuseff pluton, as well as the inconsistent variation of lithologies along contacts between the greenstone/metachert lenses and the flysch-like rocks suggest that these boundaries are purely tectonic in origin.

While regionally the basement has a metamorphic grade of only low to middle greenschist facies, there exists next to the intrusive contact of the Seno Yuseff pluton a small zone of hornfels that is locally a few hundred meters wide, and which has some lead and copper mineralization. Throughout all three basin lithologies, but much more so within the flysch-like units, a pervasive quartz veining exists which is roughly aligned with one of the structural fabrics to be discussed further on.

In addition to the three basic lithologies there occur sporadically within the basement terrane roughly planar and steeply dipping zones of breccia. As these breccias cut across the compositional layering, they are probably tectonic in origin, and will be discussed in the next section.

B. STRUCTURES OF THE STAINES COMPLEX

It has been known for many years that the pre-(?)Upper Jurassic basement rocks of the Patagonian Cordillera experienced a history of polyphase deformation prior to the regional uplift and peneplanation which on regional grounds is known to have occured prior to the mid to late Jurassic deposition of the Tobifera Formation and the intrusion of the older Jurassic components of the Patagonian batholith (Katz, 1964; Dalziel and Cortés, 1972; Halpern, 1973). With careful examination of the structural relations across the basement/cover unconformity, which is exposed over several square kilometers in this area, it was possible to identify two phases of deformation, separate from and predating the deformation which generated the open to tight folding within the cover sequences. These relations are made clear from both a consideration of macroscopic fabric relations across the unconformity as well as from a statistical evaluation of fabric data within this region.

1. Macroscopic Observations

Cleavages: The Tobifera strata, which have been openly folded into a series of upringht synclines and anticlines as well as faulted in places within this area, usually contain only one cleavage roughly parallel to the axial planes of the cover folds. This cleavage is variably developed in the Tobifera, and can be difficult to find in the rhyolitic flows or in the basal breccia.

Immediately adjacent to the unconformity the underlying basement rocks clearly contain two subparallel to the compositional layering and represents the first fabric to be developed in this rock. The second cleavage, which has more of a spaced character, is usually a crenulation-style cleavage imposed at a high angle to the bedding and found parallel to the axial planes of small scale tight asymmetric folds. Subparallel to the second cleavage in the basement is a penetrative quartz veining (see photo 3). Neither the two cleavages in the basement, nor the quartz veins, can be traced across the unconformity, and in many cases neither cleavage is parallel to the cleavage in the Tobifera strata.

Folds: The Tobifera has been openly folded in the northern extent of the map area into two anticlines and a syncline, which are illustrated on the accompanying geologic map and in cross section (A-A'). The axes of these folds trend N-S and plunge slightly to the south. Within the basement two small scale fold systems are developed. The first system of folds are tight to subisoclinal folds with axial planes subparallel to the first cleavage. These are refolded by a second series of folds which are open to tight asymmetric fold trains associated with the second spaced cleavage (see photo 6). While the original attitudes of the first folds are difficult to determine, due to their later refolding, the second set of asymmetric folds has consistent N-S axial traces. The dip of the axial planes to second folds is, however, quite variable (see Fig. 3, stereoplot c).

Fabrics within clasts of the basal breccia of the Tobifera: The basal breccia of the Tobifera Formation which directly overlies the irregularly eroded basement contains, almost exclusively, clasts of the basement which range in size from small cobbles to blocks several meters in diameter. These breccia fragments contain disoriented first and second cleavages as well as displaying many small asymmetric second folds which have quartz veins developed subparallel to their axial surface (see photo 4). These clasts clearly indicate that first and second cleavages, first and second folds, and the pervasive development of quartz veins were all developed prior to the uplift and erosion of the basement and the deposition of the Tobifera Formation.

Breccia zones: Within the basement there locally occur subparallel zones of intense brecciation. These zones contain only fragments of basement rocks, and vary from an anastomosing set of shears separating large lenses of basement to zones containing randomly oriented matrix supported basement clasts. The breccia zones cut across the basement cleavages and related folds, as well as the quartz veins, and are orientated roughly parallel to the cleavage in the Tobifera.

2. Statistical Considerations

To substantiate macroscopic relations and to ascertain the relative importance and regional orientations of the different fabric elements, first, second, and third phase deformation elements have been statistically evaluated. These structural data have been broken down by area and by relative age. Regionally, the structural data are sepa-

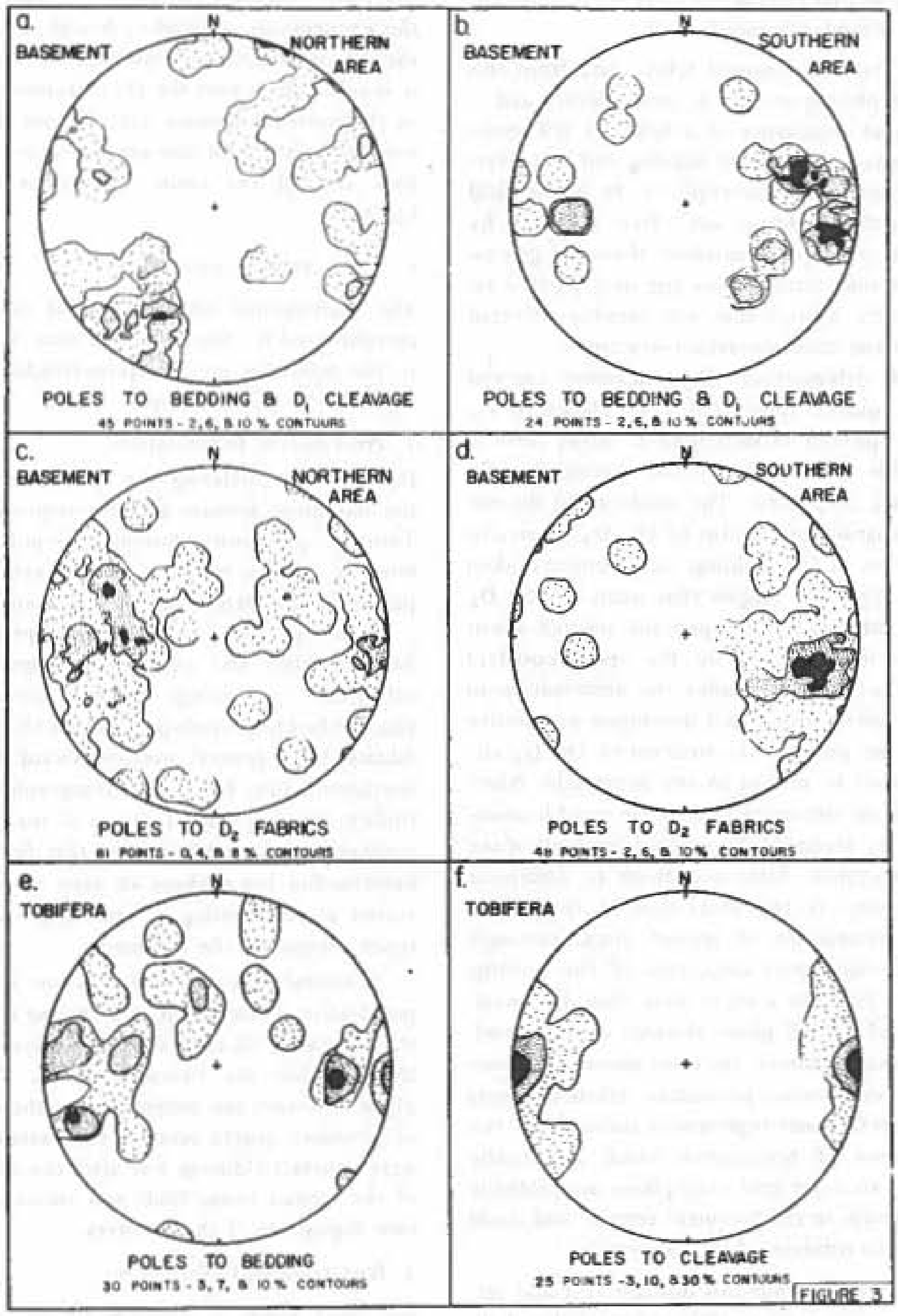
a.
BASEMENT
N
NORTHERN AREA
POLES TO BEDDING & D1 CLEAVAGE
45 POINTS - 2, 6, & 10 % CONTOURS
b.
BASEMENT
N
SOUTHERN AREA
POLES TO BEDDING & D1 CLEAVAGE
24 POINTS - 2, 6, & 10 % CONTOURS
c.
BASEMENT
N
NORTHERN AREA
POLES TO D2 FABRICS
81 POINTS - 0, 4, & 8 % CONTOURS
d.
BASEMENT
N
SOUTHERN AREA
POLES TO D2 FABRICS
49 POINTS - 2, 6, & 10 % CONTOURS
e.
TOBIFERA
N
POLES TO BEDDING
30 POINTS - 3, 7, & 10 % CONTOURS
f.
TOBIFERA
N
POLES TO CLEAVAGE
25 POINTS - 3, 10, & 30 % CONTOURS

FIGURE 3

rated into two areas, one to the north of the Seno Yuseff pluton and one to the south. The data within each area have been broken down into first and second deformation elements. The first is represented by bedding and early cleavage, and the second by second cleavages, quartz veins, and axial planes of second generation folds.

Northern Area: Contoured fabric data from this region are plotted in Fig. 3, stereoplots a and c. The regional dominance of a NNW or NW strike and a northeastward dip of bedding and first cleavage is evident from stereoplot a. In taking field measurements, bedding was often recorded by taking the envelope orientation of second generation (D_2) fold trains. Thus the data plotted represent early fabrics that are variably affected by second and third generation structures.

Second deformation (D_2) elements (second cleavages, quartz veins, and axial planes to D_2 folds) are plotted in stereoplot c. While there is considerable variation in the data, a general north-south trend is apparent. The similarity in the statistical variation in the dip of the D_2 fabrics to the variation in the bedding measurements taken from the Tobifera suggest that many of the D_2 elements may have been partially rotated about the hinge lines defined by the open (post-D_2) folds in the Tobifera. Unlike the deformation in the cover which has a well developed penetrative cleavage, the possible D_3 rotation of the D_2 elements cannot be related to any penetrative fabric element in the basement. Due to the variable orientation of D_2 elements the original vergence of the second generation folds is difficult to determine with certainty. In two areas close to the unconformity orientations of second phase cleavages were such that upon correction of the bedding tilt of the Tobifera a slight (less than 30°) westward dip of second phase cleavage was obtained.

As mentioned above, the third phase of deformation did not produce penetrative fabric elements and is therefore not represented statistically. However, zones of brecciation which are locally subparallel to cover fold axial planes are probably quite extensive in the basement terrane, and could be related to rotation of D_2 elements.

Southern Area: Within this domain first and second cleavages are all roughly subparallel and do not show the same degree of variation in dip as that observed in the northern domain (see stereoplots b and d). However from the similarity of lithologies and structural fabrics it is concluded that, in this area, the second phase of deformation resulted in the transposition of the first phase elements into the axial plane orientation of D_2 folds and cleavages (compare the distributions of the elements in stereoplots b and d). Also, from the relatively coherent distribution of D_2 fabrics it would appear that the D_3 disruption evidenced in the northern domain data did not significantly rotate D_2 fabrics of this area, or if it did, it must have rotated the entire domain as a coherent block.

C. STRUCTURAL SYNTHESIS

The macroscopic observations, as extended and corroborated by the statistical data, lend support to the following pre- and post-Tobifera structural evolution of the basement.

1. Pre-Tobifera Deformation

Deformation predating the uplift and erosion of the basement terrane and the deposition of the Tobifera, previously described as polyphase, can now be broken up into two discrete structural phases for the Peninsula Staines region.

A first phase of deformation imposed tight to isoclinal folds and an early cleavage, now seen subparallel to bedding. The macroscopic orientations of bedding envelopes indicate that first phase fabrics have general northwestward trends and northward dips. From the stratigraphic incompatibility and inconsistent nature of many lithologic contacts it seems likely that this first phase of deformation (or perhaps an even earlier one) involved some thrusting or imbrication of the rock types composing the basement.

A second phase of deformation involved the penetrative development of a second cleavage and the generation of small scale tight asymmetric fold trains within the basement rocks. The second phase cleavages are subparallel to the orientation of pervasive quartz veins in the basement, which were generated during and after the development of the second phase folds and cleavages, but before deposition of the Tobifera.

2. Post-Tobifera Deformation

The third phase of deformation did not involve ductile or penetrative deformation of the Staines Complex. However as the cover/basement uncon-

TABLA 1 Comparison of Recently Studied Basement Complexes, S. Chile.

Area	* Protoliths	◆ Metamorphism	* Structures	References
Chonos Archipelago	I, II, III	Greenschist or lower	a) NW– –SE b) NE– –SW	Herve *et al.*, 1976
Canal Baker, Lago Cochrane area	I, II, III, IV	Greenschist or lower	a) NW– –SE b) NE– –SW c) N– –S	Kizake; Nishimura, 1977; Forsythe, unpub. data
Madre de Dios Archipelago	I, II, III, IV	Greenschist or lower	a) E– –W b) NW– –SE c) N– –S	Forsythe; Mpodozis, 1979; Cecioni, 1956
Estrecho Nelson area	I, II, III, IV	Greenschist or lower	?	Cecioni, 1956; Forsythe, unpub. data
Desolación area	I, II	Greenschist or lower	NW– –SE	Forsythe, 1978
Peninsula Staines	I, II, III	Greenschist or lower	a) NW– SE b) N– S	Dalziel *et al.*, 1975; Forsythe; Allen, this report

* I: Flysch-like sequences; II: Metachert; III: Metabasalt; IV: Carbonate.

◆ Regional metamorphic grade, excludes locally high facies of contact metamorphism.

* Strike of principal foliations or compositional layering.

formity is folded along with the basal portion of the Tobifera Formation, and as D_2 structures within the Staines Complex display a range of orientations similar to that of the bedding in the Tobifera Formation, it seems likely that the deformation that folded the Tobifera Formation in some way also affected the adjoining basement rocks. The breccias that have been noted in the Staines Complex that are roughly parallel to the cleavage in the Tobifera Formation, and that cut both first and second phase deformation structures may have been one means by which strain was accommodated in the Staines Complex during cover deformation

D. REGIONAL CORRELATION

In recent years work has been completed, or is in progress, on many of the pre-(?)Upper Jurassic basement complexes in southernmost Chile. While the state of knowledge of these terranes is far from complete the surveys can be used in a general sense to compare lithologic, metamorphic and structural characteristics to those of the Staines Complex. Table 1 lists six of these complexes.

All of these complexes contain chert or metachert, all but the Desolación area have metabasalt or greenstone in association with the metachert, and in all six of the zones the flysch-like units form the predominant rock type. In all complexes metamorphic grades are low, showing no signs of regional metamorphism above the greenschist facies. The prevalent direction of principal foliations within these terranes is quite variable, as is to be expected as each of these terranes have a polyphase history. However the number of complexes that have foliations that trend obliquely to the north-south direction of the present Andes is quite high.

The association of chert, greenstone, limestone and flysch-like sedimentary rocks found throughout all of these terranes has been interpreted for specific areas to be representative of a fore-arc assemblage (Dalziel *et al.*, 1975; Barker, Dalziel *et al.*, 1976; de Wit, 1977; Forsythe, 1978) which includes allochthonous slices derived from a formerly convergent ocean floor (Forsythe and Mpodozis, 1979). The prevalence of these units both to the west of the Staines Complex as well as to the north and south suggests that the entire basement of the region had a similar history of development involving accretion and continued deformation in a late Palaeozoic to early Mesozoic arc trech gap region.

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