Report on

1:100 000 Scale Geological and Metallogenic Maps
Sheet 3366-24

Provinces of San Luis and Córdoba

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GEOSCIENTIFIC MAPPING OF THE SIERRAS PAMPEANAS ARGENTINE-AUSTRALIAN COOPERATIVE PROJECT

AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION

1997

CONTENTS

SECTION I: GEOLOGY

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1. INTRODUCTION

1.1 LOCATION AND ACCESS

The **3366-24** map area stradles the extreme southern part of the Sierras Comechingones within the Córdoba Province between 32°40’-33°20’ S and 64°00’-65°30’ W. The area is part of the 3366-IV (unnamed) 1:250 000 map sheet area.

The only population centre is Achiras and access is via Ruta Provincial 1. Additional access is provided by unsealed roads to the south and to Las Albahacas to the north, in adjoining sheet areas. The main access to main range of the Sierras Comechingones, in the northwest, is provided by numerous tracks on the Es. Monte Guazú. The southeast-flowing A° de la Cruz and Achiras provide the main drainage catchments off the Sierras.

1.2 NATURE OF WORK

The mapping of the Sierras Comechingones was carried out in 1995 and 1996 under the Geoscientific Mapping of the Sierras Pampeanas Argentina - Australia Cooperative Project by geologists from the Australian Geological Survey Organisation (AGSO) and the Subsecretaría de Minería, Argentina (DNSG). The mapping employed a multidisciplinary approach using newly acquired high-resolution airborne magnetic and gamma-ray spectrometric data, Landsat TM imagery, and 1:20 000 scale (approximate) black and white air photography.

The **3366-24** geological map was compiled using topographic bases produced at photo-scale from rectified Landsat images controlled by field GPS sites. Topography, including cultural and hydrography data were derived from the rectified Landsat images, and the relief data was derived from the digital terrane model (DTM) acquired during the airborne geophysical survey.

Geologists involved in the fieldwork were P.G. Stuart-Smith (AGSO), and J.C. Candiani and R. Miró (DNSG).

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Figure 1. Simplified regional geology of the southern Sierras Pampeanas, and location of the three project areas of the Geoscientific Mapping Project, including the San Luis area.

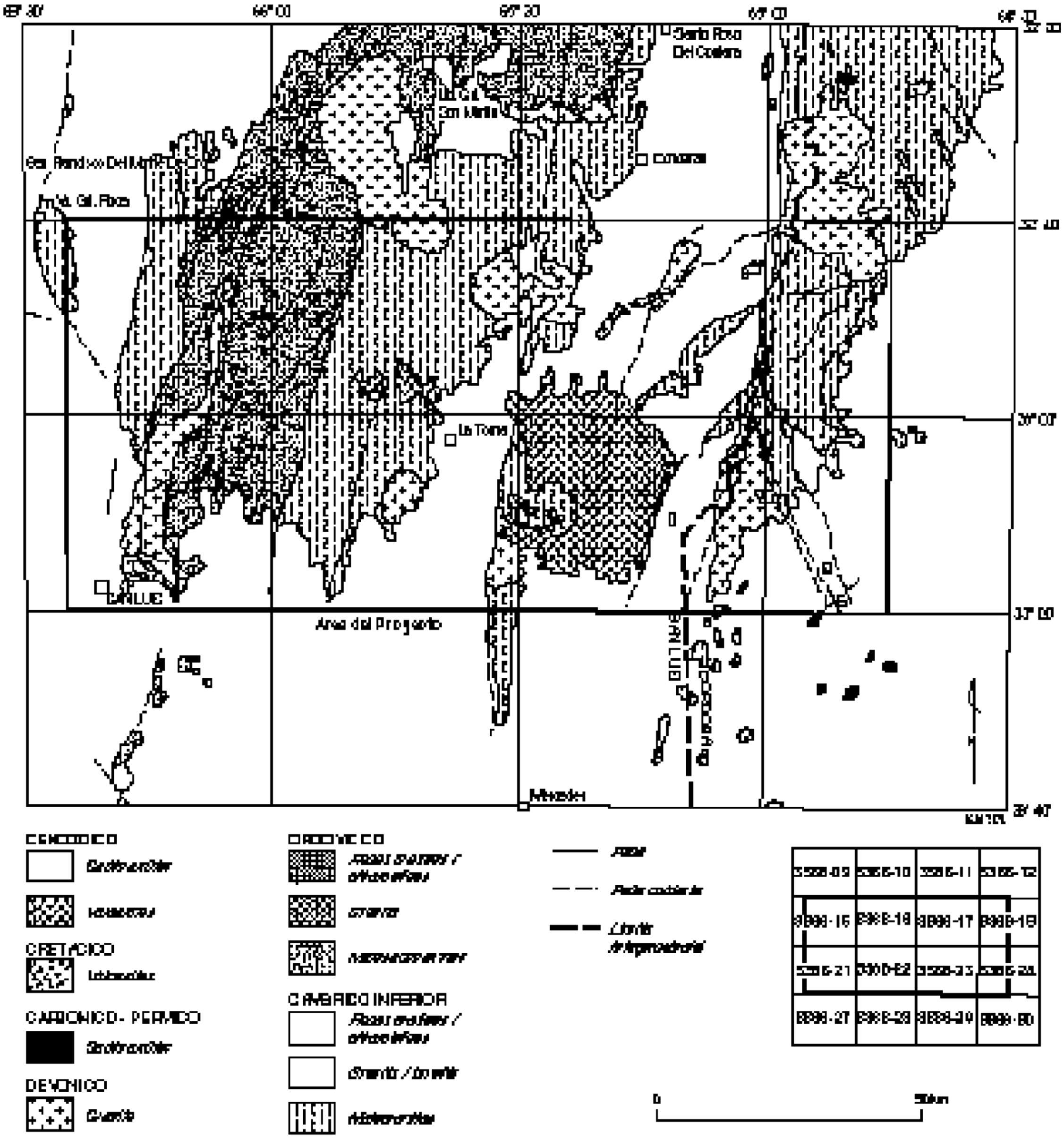

Figure 2. Location of the *Sierras de San Luis y Comechingones* 1:250,000 scale map area in San Luis and Córdoba Provinces with generalised geology. Locations of 1:100,000 scale map areas are indicated.

1.3 PREVIOUS INVESTIGATIONS

Previous geological investigations of the Sierras Comechingones includes regional 1:200 000 scale geological mapping of Hoja 24 by Sosic (1964) and stream sediment geochemical mapping of the Sierras Comechingones by Candiani and Maza (1982). More recent investigations have concentrated on the metamorphics and granites near Achiras (Otamendi and others, 1996; Fagiano and others, 1992; and Nullo and others, 1992).

2. STRATIGRAPHY

2.1 GENERAL RELATIONS

The Sierras Pampeanas are a distinct morphotectonic province of early- to mid-Palaeozoic metamorphic, felsic and mafic rocks that form a series of block-tilted, north-south oriented ranges separated by intermontane basins. These ranges are bounded by escarpments developed on moderate to steeply dipping reverse faults developed during the Cainozoic Andean uplift (Jordan and Allmendinger, 1986).

Recent geological and geophysical surveys conducted during the Cooperative Argentine-Australia Project in the Sierras Pampeanas show that the Paleozoic basement of the southern Sierras Pampeanas contains of a number of distinct lithological, structural and metamorphic domains separated by major tectonic zones. There are two principal domains: an older, Cambrian domain, and a slightly younger, Ordovician domain. Both domains share a common geological history since early Devonian times. Only the older domain is present in the **3366-24** sheet area.

Rocks in the **3366-24** sheet area include the Monte Guazú and Conlara Complexes, deformed and metamorphosed during the Early Cambrian Pampean Cycle. These units are intruded by Early Devonian granites and are partly covered by Cainozoic continental deposits. A summary of the stratigraphy and relations is shown in Table 1.

Table 1. Summary of stratigraphy and relationships in sheet **3366-24.**

Age (Ma)	***Unit***	***Description***	***Relations***
CAINOZOIC QUATERNARY	Alluvium	Unconsolidated clay, sand and gravel	Deposits along active river courses
TERTIARY TO QUATERNARY	Undivided loess and fluvial deposits	Clay, sand, gravel, paleosol	Mantles older units.
	Paleosols	Clay, soil, caliche	Forms thin cappings over basement rocks. Overlain by intercalated younger fluvial and aeolian deposits.
DEVONIAN (382 Ma)	Las Lajas Shear Zone		
	Achiras Igneous Complex	Flow-banded granite and leucogranite, minor enclaves of banded gneiss, schist, amphibolite and pegmatite	Forms layered igneous complex. Intrudes Conlara Complex
	Undifferentiated granite		Intrudes Monte Guazú Complex
	Inti Huasi Granite		Intrudes Monte Guazú Complex
CAMBRIAN	Conlara Complex	Pelitic and psammitic schist, amphibolite, granite, pegmatite	Faulted against Monte Guazú Complex and Las Lajas Shear Zone. Intruded by Achiras Igneous Complex
	Monte Guazú Complex	Banded garnet-sillimanite-muscovite-feldspar-quartz gneiss, tonalitic ortho-gneiss, marble, calc-silicate rocks, meta-mafic rocks	Intruded by Inti Huasi Granite, faulted against Conlara Complex

2.2 PALAEOZOIC METAMORPHIC BASEMENT

2.2.1 INTRODUCTION

The metamorphic basement of the **3366-24** sheet area consists of Cambrian metasediments and intrusives that were deformed and metamorphosed during the Cambrian Pampean Cycle. These early Palaeozoic metamorphic rocks have been divided on the basis of composition into the Monte Guazú Complex and the Conlara Complex. These complexes are intruded by a Devonian Granites and are locally deformed within a regional mylonite zones that formed during the Achalian tectonic cycle.

2.2.2 CAMBRIAN

Monte Guazú Metamorphic Complex (€ggn, €ga, €gt)

Pelitic gneiss, tonalitic orthogneiss, meta-mafic rocks, marble and calc-silicate rock

The Monte Guazú Complex is the main basement unit forming the southern Sierra de Comechingones. The area was mapped by Candiani and Maza (1982) as part of stream-sediment geochemical mapping program, and later, in the south, Otamendi and others (1996) mapped and described the unit as "Metamorfítas Monte Guazú", including it in the Las Lajas Complex. The unit occupies the area north of Estancia Inti Huasi. Outcrop of the Complex is good to excellent in the sierras with gneiss forming low strike ridges.

The complex comprises interlayered metasedimentary and meta-intermediate and mafic rock, all of which were metamorphosed and deformed during the Early Cambrian Pampean Cycle. The unit is intruded by the Inti Huasi Granite and an undifferentiated body at Cerro Negro. In the west, the unit is faulted against and thrust over the Conlara Complex. A thin veneer of unconsolidated Cainozoic continental sediments limits the easterly extent of the complex with erosional remnants forming cappings along parts of the Sierra de Comechingones.

The complex contains four main lithologies: pelitic gneiss; tonalitic orthogneiss; meta-mafic rocks; and minor marble and calc-silicate rocks. All are interlayered, and have the same medium-grade metamorphic and deformational history. Both the tonalitic orthogneiss and the meta-mafic rocks are interpreted as originally intrusive into the metasedimentary protoliths. Although having a similar composition and deformational/metamorphic history as the Conlara Complex, the latter complex is distinguished by the absence of tonalitic orthogneiss and the less feldspathic nature of the pelitic gneiss.

Banded, grey, garnet±sillimanite±muscovite-K-feldspar-biotite-plagioclase-quartz gneiss is the most abundant rock type, comprising about 80% of the Monte Guazú Complex. It is interlayered with minor calc-silicate rock, tonalitic orthogneiss and contains boudinaged pods of amphibolite, marble and pegmatite. Leucosome lenses and bands, a few cm's wide, are common and, in places, the texture is migmatitic. The medium-grade gneissic fabric is mostly rotated into parallelism with moderately-ENE dipping penetrative D3 shear planes. In zones of higher D3-strain, such as the zone passing southwest of Cerro Negro, this foliation has almost obliterated earlier fabrics and the gneiss is converted to mylonite with biotite replaced by chlorite and hematite, and sillimanite altered to fine muscovite aggregates.

Grey equigranular tonalitic orthogneiss is the second most abundant lithology within the Monte Guazú Complex. It is interlayered with the other rocks and is common, particulary in the south where it comprises over 50% of the unit and is faulted against the structurally underlying Conlara Complex. The rock consists essentially of granoblastic polygonal medium-grained plagioclase and quartz, with biotite ± hornblende. Acessories include zircon, apatite, allanite, magnetite and rare pyrite. Rare muscovite occurs as porphyroblasts and as microcrystalline secondary folia. The principal penetrative foliation (S1), is defined by aligned biotite, and a weak mineral lineation (L1) is defined by aligned biotite and quartz ribbons. Weak chlorite, hematite, carbonate, sericite and epidote alteration is widespread, especially within D3 mylonitic zones. Veins of tourmaline-muscovite pegmatite are present, proximal to the Conalra Complex. Geochemically the gneisses are oxidised and metaluminous to slightly peraluminous with ASI ratios of between 0.9 and 1.1, falling within the “I-type” field of Chappell and White (1974).

Very minor meta-mafic rocks, are interlayered throughout the complex forming isolated pods or semi-continuous bands that are boundinaged within the penetrative, D1 metamorphic fabric. Individual bodies range up to a few metres to more in length. Pegmatite commonly forms small fringes developed at boudin necking points. The rocks are mostly banded ortho-amphibolite comprising weakly aligned fine- to medium-grained subprismatic hornblende, with granoblastic polygonal plagioclase and quartz, and minor titanite. Minor diopside, carbonate, muscovite, K-feldspar and epidote may also be present. The rocks preserve a differentiated medium-grade gneissic fabric formed during D1 which was little affected by later deformation. Similar meta-mafic rocks to those in the Monte Guazú Complex occur north of the Cerro Aspero Batholith in the Sierras Comechingones. These have been interpreted as transitional tholeiites with within-plate affinities (Demichelis and others, 1996), which were derived from a primary basic magma generated by low-degree partial-melting of an OIB-type asthenospheric mantle source (Demichelis and others, 1996).

Marble and banded calc-silicate gneiss, are a minor consituents of the complex, forming isolated bodies.

Conlara Complex (€cgn, €ce)

Pelitic and psammitic schist and gneiss; orthogneiss, minor calc-silicate rock and marble; pegmatite.

The Conlara Complex, comprises the majority of the basement outcropping within the valley (Valle del Río de Conlara) between the Sierras de San Luis and Sierra de Comechingones. The Conlara Complex also incorporates the metamorphic part (the “Metamorfítas y Anatexítas India Muerta”) of a previously defined metamorphic-intrusive complex, the Achiras Complex (Otamendi and others, 1996), in the extreme south of the Sierra de Comechingones. The igneous part of the Achiras Complex of Otamendi and others (1996) has been redefined as the Achiras Igneous Complex.

The Conlara Complex comprises dominantly late Neoproterozoic - early Cambrian sediments polymetamorphosed in the early-mid Palaeozoic. The thickness of the sedimentary sequence is unknown due to complex structures, transposition foliation and the lack of definitive bedding. The Complex is intruded by a series ofsubconcordant granite sheets of the Devonian Achiras Igneous Complex, which post-dates the dominant structural and metamorphic episodes.

Metapelitic and metapsammitic quartz-feldspar-biotite-muscovite-garnet-sillimanite ±tourmaline±chlorite schist is the most abundant rock type in the Conlara Complex (approximately 50%). The schist contains a well-developed biotite-muscovite foliation that is openly folded at a meso- to macro-scopic scale with long, generally shallowly dipping limbs. Strongly corroded sillimanite, biotite coronas on garnet, and coarse poikiloblasts of muscovite and quartz containing tightly crenulated inclusions of sillimanite, suggest that the dominant fabric is a low temperature overprint of an earlier higher-grade (amphibolite-facies) fabric. Biotite and muscovite define a generally east plunging mineral lineation while shear-sense indicators are well developed and show a dominantly east-up displacement. In places, the schist contains a metamorphic differentiated layering that consists of alternating leucosome and millimetre-scale quartz-rich layers. Within a kilometre of the Las Lajas Shear Zone the schists are mylonitic and boudinaged, and chloritic alteration of biotite is common.

Metapelitic and metapsammitic quartz-feldspar-biotite±garnet±sillimanite gneiss is the next most abundant unit within the Conlara Complex (~40%). It is clearly distinguished from the schist by the paucity of muscovite in the foliation, and more massive outcrop style. Where secondary muscovite is developed, it is generally unoriented and a minor component of the mineral assemblage, or it is associated with discrete overprinting shear bands, where it is associated with biotite. Leucocratic and/or pegmatitic veins are common in this rock type and typically define the main foliation, which is tightly to isoclinally folded (and refolded) at a meso- to micro-scopic scale.

Felsic orthogneiss is interlayered with both the gneiss and schist and constitutes a relatively minor component of the complex. The orthogneiss is strongly foliated and consists dominantly of equigranular quartz, feldspar and biotite with minor muscovite. The foliation in the orthogneiss appears to be contiguous with the earliest fabric in the enclosing rocks and suggests that the original granite was emplaced during either the early Cambrian Pampean Orogeny.

Calc-silicate and marble, found within the unit to the west in the Sierra de Yulto, Sierra Los Morillos, Sierra del Morro and Sierra de La Estanzuela, are not prtesent in the sheet area.

Various generations of quartz-feldspar-biotite±muscovite±tourmaline±garnet pegmatite also occur within the Conlara Complex. Early generations are strongly deformed and are elongate and boudinaged in the schist and gneiss. Later generations are somewhat less deformed and are spatially associated with Devonian granites. The magnetic susceptibility of the pegmatites is extremely low. Late-stage aplite and quartz-tourmaline dykes and veins that are generally stongly lineated, are also common within the Complex and are typically found in NW or SW trending sets.

2.3.1 DEVONIAN

Las Lajas Shear Zone (Dlmi)

Mylonitic schist, granite, marble, orthoamphibolite, pegmatite and serpentinite

The Las Lajas Shear Zone is a linear northwest-trending high strain zone, traversing the southern Sierra Comechingones. It extends from near Villa Carmen in the northwest (in **3366-17** sheet area) to east of Achiras. The zone, ranging from 1 to 2 km wide, can be traced on aeromagnetic images further to the southeast towards Sampacho, beneath a thin cover of Cainozoic sediments. The shear zone, named after Estancia Las Lajas, has been described by Otamendi and others (1996) who differentiated two subunits, the "Unidad Metamorfítas Loma Blanca" and the "Unidad Metamorfítas Monte Guazú". The name Las Lajas Shear Zone is used here only for those rocks placed within the "Unidad Metamorfítas Loma Blanca". The "Unidad Metamorfítas Monte Guazú" has been renamed the Monte Guazú Complex. Rocks in the shear zone are mostly well exposed within the numerous quarries located in marble lenses.

The shear zone is a mylonitic melange of metamorphic and intrusive rocks, and is faulted-bounded within the Conlara Complex. The main penetrative greenschist-facies mylonitic fabric cross-cuts the Achiras Igneous Complex (382 ± 6 Ma) and hence must be no older than Early Devonian in age. Pelitic schist predominates with lesser granite, marble, amphibolite, pegmatite and rare serpentinite.

Sillimanite-bearing feldspar-muscovite-biotite-quartz schist is the predominant rock type in the shear zone. The schist is more quartz-rich than gneiss in the Monte Guazú Complex but is indistinguishable from that of the enclosing Conlara Complex. The schist is typically finely-banded with an early amphibolite grade foliation defined by sillimanite and differentiated mica-rich folia, leucosome and minor quartzitic bands. This fabric is cut by variably developed mylonitic shear planes associated with recrystallised quartz ribbons and a retrograde greenschist overprint of chlorite, hematite and geothite. Pegmatite veins within the schist are boudinaged and S-C fabrics are locally defined by asymmetry of deformed leucosome clasts.

Pink to buff medium-grained recrystallised equigranular leucogranite comprises about a third of the unit, forming concordant sheets interlayered with schist and other rocks within the shear zone. Foliated metamorphic muscovite and rare relict primary biotite together with bands of granoblastic polygonal quartz and feldspar define a well-developed moderate east-dipping mylonitic foliation with a quartz-muscovite mineral lineation. S-C fabrics are common. Rare idioblastic garnet is present in places, showing sericitic alteration. The granite is indistinguishable to that in the Achiras Igneous Complex.

Lenses of white to grey banded marble, up to 500 m thick and 5500 m long, make up about 20% of the unit, and occur throughout the entire length of the exposed shear zone. The marble is typically strongly mylonitised with a prominent lineation.

Minor orthoamphibolite lenses (~5%) occur throughout the shear zone, interlayered with schist and marble. The amphibolite is a fine-grained, banded, dark green to black rock consisting mostly of prismatic hornblende, quartz and plagioclase. Bands of recrystallised quartz, carbonate, plagioclase and epidote define a penetrative greenschist facies mylonitic foliation with lineated quartz.

Semi-concordant pegmatite veins comprise up to 5% of the shear zone, forming boundinaged lenses or deformed veins intruding all other rock types. They are mostly white to buff in colour and contain up to 6% muscovite and trace amounts of biotite, garnet or tourmaline. A penetrative mylonitic foliation, defined by recrystallised granoblastic polygonal bands of quartz and deformed muscovite folia, contains a quartz-mica mineral elongation lineation.

2.3 PALAEOZOIC IGNEOUS ROCKS

2.3.1 INTRODUCTION

In the Sierras Comechingones Palaeozoic igneous rocks were intruded into the Monte Guazú and Conlara Complexes during the Cambrian and Devonian. The Cambrian intusive rocks, comprising mostly meta- mafic rocks and tonalite are deformed and metamorphosed with the metasediments forming the metamorphic basement complexes. During the Devonian Achalian Cycle these complexes were intruded by fractionated granitic bodies. In the **3366-24** sheet area an intrusive complex of subconcordant granite sheets (the Achiras Igneous Complex) and a zoned pluton (the Inti Huasi Granite) are distinguished.

2.3.2 DEVONIAN INTRUSIVES

Inti Huasi Granite (Dgi)

Small hills and isolated outcrops of granite on the eastern flank of the Sierra de Comechingones, north of La Barranquita, about 35 km northeast of Achiras, were named the Inti Huasi Granite. The granite crops out as low rocky pavements and bouldery hills around Cerro Inti Huasi, and Estancias Los Cerros and La Piedra.

Magnetic anomalies indicate that the granite exposures form part of the western border of an elliptical-shaped zoned pluton about 12.5 km across, comprising a non-magnetic core and a magnetic border facies about 4 km wide. The bulk of the pluton, including the entire non-magnetic zone, extends to the east beneath Cainozoic and Quaternary sediments at shallow depth (<200 m). Contacts between the granite and surrounding basement rocks of the Monte Guazú Complex to the northwest are not exposed. However, the magnetic anomalies indicate that the pluton truncates early Devonian structures in the complex, consistent with the massive nature and lack of penetrative structures in granite outcrops.

Although there are no isotopic age data for the granite, the shape and zoned form of the pluton suggests it may be part of the Early Devonian suite of granites.

Outcrops of the pluton are typically coarse grained pale pink equigranular leucogranite. Biotite forms less than 2% of the rock and is partly altered to chlorite. Up to 3% muscovite is present, both as primary interstitial grains and as a secondary alteration of oligoclase, together with trace carbonate and epidote. The leucogranite forms the outer magnetic phase of the pluton with an average magnetic susceptibility of 258 x 10^{-5} SI units. Trace magnetite is present in unaltered specimens, however, it is replaced by hematite where the granite is intensely jointed. Relative to other basement rocks in the region the leucogranite has a high total count (123 cps) with high uranium (8.5 cps).

Limited geochemical data indicates that the Inti Huasi Granite is an oxidised peraluminous granite indistinguishable from other Achalian Granites.

Achiras Igneous Complex (Dag, Dagl)

Interlayered granite, leucogranite

An intrusive complex, defined as the Achiras Igneous Complex, forms the extreme south of the Sierras Commechingones centred on the town of Achiras. This complex comprises the intrusive part (the “Granito Los Nogales”) of what was previously termed the Achiras Complex by Otamendi and others (1996). Outcrop of the the complex is good but becomes poorer south of Provincial Route 1 where elevation is lower and topography more undulating. Aeromagnetic anomalies, however, indicate that the complex extends under thin unconsolidated Cainozoic sediments, to the south.

The intrusive complex comprises a stratified, subconcordant granite suite. The unit consists mainly of two different granite types, a coarse seriate strongly magnetic granite and a non magnetic equigranular leucogranite-granite. Late-stage aplite and tourmaline-garnet-muscovite-bearing pegmatite dykes are common. The granites form sheet-like bodies which display mostly concordant but intrusive contacts, postdating earlier, differentiated, high-grade metamorphic fabrics within the metamorphic basement. U-Pb zircon age determinations of the magnetic granite yield a crystallisation age of 382 ± 6 Ma (Camacho and Ireland, 1997). This contrasts with previous authors (e.g. Fagiano and others, 1992; Nullo and others, 1992) who interpreted an Early Ordovician age for the granite, correlating it with the syn D2 granitic group of Rapela and others (1990).

The complex is structurally stratified from dominatly magnetic, seriate granite at the base, through to dominantly leucogranite/granite at the top. These two informal subunits are entirely gradational and represent only a change in proportion of the constituent rock types. The lower subunit was previously mapped as "Granito Los Nogales" (Fagiano and others, 1992; Nullo and others, 1992), while Otamendi and others (1966) used the term "Granito Los Nogales" for granites in both the subunits.

Pink, coarse-grained, seriate biotite-granite is the predominant rock (90%) in the structurally lowest of the subunits, forming only a minor component of the overlying granite-leucogranite dominated subunit. The granite is distinguished by its strongly magnetic character (magnetic susceptibilities about 500-1500 x 10^{-5} SI) and the presence of rare hornblende and common, pink, perthitic microcline crystals, which are up to 5 cm across. Apatite, magnetite and lesser pyrite are accessories. In places, weakly aligned biotite and pegmatite bands define flow banding. Xenoliths of pelitic gneiss, amphibolite and tonalite are common as concordant enclaves parallel to flow banding.

Flow-banded, pink to grey, medium- to coarse-grained, equigranular biotite-granite to leucogranite forms about 70% of the upper subunit and is a minor constituent in the remainder of the complex. The granite is equigranular with a ubiquitous flow-banded fabric evident by aligned biotite, concordant pegmatitic bands and patches, and schlieren and lenses of pelitic gneiss. Zircon, apatite, and rare garnet are accessory phases. Muscovite is a minor primary consituent but is more abundant as a secondary mineral in zones adjacent to the Las Lajas Shear Zone where the granite has a mylonitic fabric. In these areas biotite is replaced by chlorite and quartz and muscovite form a ENE-dipping mineral lineation on a muscovite-rich mylonitic foliation. Very weak carbonate, epidote, sericitic and hematitic alteration is widespread. Small fibrous aggregates of sillimanite with muscovite reaction rims are present near contacts with gneiss and possibly represent minor contamination of intrusive margins with host pelitic gneiss.

Interlayered grey banded, feldspar-biotite-quartz (±garnet±muscovite) gneiss and (±garnet±sillimanite±feldspar) muscovite-biotite-quartz schist occur throughout the complex as concordant enclaves and xenoliths within the layered seriate granite and granite-leucogranite intrusions.

Geochemically both the seriate granite and equigranular granite-leucogranite form a fractionated suite, the latter the most fractionated. They have similar major and trace element trends to other Devonian granites, and are peraluminous with an ASI of about 1.1. However, they differ in that they show little enrichment in Rb, Y, U with fractionation compared to other granites of the same age and are mostly less oxidised.

The granites have been interpreted as products of local anatexisis (Fagiano and others, 1992; Nullo and others, 1992; Otamendi and others, 1996) with emplacement conditions estimated at >700°C and 3Kb (Fagiano and others, 1992). This interpretation has been largely based on the interpretation of a tectonic origin for biotite alignment in the granites and a correlation with the principal second deformation phase (D2) of Dalla Salda (1984).

It is clear from this study that the alignment of biotite is a product of magma flow and that the granite truncates both D1 and D2 fabrics and is only affected by greenschist facies deformation. The granites probably represent products of a fractionated granitic magma, derived from metasedimentary sources, which intruded the Early Cambrian metamorphic rocks at mid/upper crustal levels during the Early Devonian as a series of multiple injections during progressive mylonitisation and eventual truncation by a greenschist facies high-strain zone, differentiated as the Las Lajas Shear Zone.

A major swarm of pegmatites is spatially associated with the Achiras Igneous Complex. The pegmatites occur as either semiconcordant veins intruding both granitic and gneissic rocks, or as discordant, mostly NW- and NNW-trending tourmaline-bearing veins. The concordant variety form part of the layered granite complex and represent highly fractionated melts injected during multiple granite intrusion. The discordant variety are more common and more widely distributed than the earlier pegmatites. They are spatially associated with the Las Lajas Shear Zone and concentrated within the basement hanging-wall. In places, they crosscut folds formed during the mylonite formation, and in others, they are strongly mylonitised. These relationships indicate that the discordant pegmatites intruded during thrusting on the Las Lajas Shear Zone and represent the final products of felsic magmatism in this region.

Undifferentiated granite (Dg)

A number of small granite (sensu latu) bodies occur within Sierras Comechingones. The largest of these outcrops at Cerro negro in the north. The granites range in composition and texture and are essentially undeformed. Proximity to intrusions of known Devonian age, or intrusive relation with Devonian granites, suggest that these small undifferentiated granites are of similar age.

2.3.3 MINOR DYKE ROCKS

Pegmatite (peg)

Several generations of pegmatite dykes intrude basement metamorphics and granitic rocks. The oldest are represented by zoned garnet-muscovite-rich types that form small deformed pods, up to several m wide within the gneiss of the Monte Guazú and Conlara Complexes. These pegmatites are probably the product of partial melting during M1 (Cambrian) metamorphism.

The youngest pegmatites are associated with the Early Devonian Achiras Igneous Complex where they form a major swarm of either semiconcordant veins intruding both granitic and gneissic rocks, or discordant NW- and NNW-trending tourmaline-bearing veins. The multiple phases of pegmatite evident in the complex and their spatial relationship to the Las Lajas Shear Zone suggests that the Devonian granitic magmatism was fairly extended in time and was related to the deformation cycle.

Lamprophyre

A swarm of long linear lamprophyre (minette) dykes intrudes the Monte Guazú and Conlara Complexes in the southern part of the Sierra de Comechingones. Individual dykes, may be up to 10 m wide, and extend discontinuously for up to 10 km. Typically, the dykes are negative topographic features and poorly exposed as small, spheroidally-weathered boulders, lying between resistant outcrops of the basement rocks. A chilled margin is commonly developed in the lamprophyres. The dykes trend northwesterly, parallel to faults developed at the close of the Devonian Achalian deformation.

The precise age of the dykes is not known from either region, however, they clearly postdate Late Devonian thrusts and therefore must be late Paleozoic or Mesozoic in age. Toselli and others (1996) interpret similar lamprophyre dykes, intruding the Granito Ñuñorco in the western Sierras Pampeanas, to be related to the late Devonian/upper Carboniferous “Chánica Orogeny”.

2.4 CAINOZOIC

Tertiary to Quaternary

Paleosols (**Czc**)

In the higher parts of the Sierras Comechingones and at the eastern foot of the ranges, paleosols (**Czc**), commonly with a hardpan of calcrete, forms thin (a few metres thick) remnant cappings over basement rocks. They are best exposed along the gently sloping eastern flanks of the ranges where they are overlain by intercalated Tertiary to Quaternary fluvial and aeolian deposits. The age of the deposits is not known. Their formation predates the last significant uplift which probably took place during the Late Pliocene-Pleistocene (Costa, 1996).

Undivided loess, alluvial deposits, fans, gravels, caliche, channel deposits (Czu)

The most extensive Cainozoic unit is an intercalted sequence of undifferentiated Tertiary to Quaternary fluvial and aeolian deposits and paleosols which cover a large part of the Pampean region and onlap the base of the Sierras Comechingones in the east. The unit consists of pinkish loess intercalated with fluvial and aeolian deposits comprising mostly friable illite and silt, with material derived from both the metamorphic-igneous basement rocks and a volcanic-pyroclastic source (Strasser and others, 1996). Strasser and others (1996) have correlated the stratigraphically younger deposits in the San Luis region with Late Pleistocene and Holocene units in the Buenos Aires Province.

2.5 QUATERNARY

Active alluvial deposits (Qa)

Alluvial deposits of clay, sand and gravel occur along all the active the river courses draining the Sierra Comechingones**.** The most extensive of these are developed on the loess plain east of the Sierra Comechingones where narrow floodplains are associated with most of the rivers.

3. TECTONICS

Three major deformation/metamorphic and magmatic events have affected the basement rocks of Sierras Comechingones (the Monte Guazú and Conlara Complexes, Las Lajas Shear Zone) The three tectonic events are termed here the Early Cambrian Pampean Cycle, the early Ordovician Famatinian Cycle, and the Devonian Achalian Cycle. All regions were also affected by reverse faulting and block-tilting during the Cainozoic Andean Cycle.

3.1 PAMPEAN CYCLE

Early Cambrian deformation and metamorphism

The oldest preserved structural feature in Sierras Comechingones is a medium- to high-grade metamorphic differentiated foliation which is well-preserved in pelitic gneiss and amphibolite of the Monte Guazú and Conlara Complexes. The foliation (S1), which is variably developed, is typically a penetrative gneissic foliation in pelitic gneiss, defined by leucosome lenses and a mineralogical layering defined by biotite, quartz and sillimanite with a lineation (L1) defined by sillimanite and quartz. In tonalitic orthogneiss, aligned biotite forms S1 folia, with a weak biotite and quartz lineation. In amphibolite and calcsilicate rocks the foliation forms strongly differentiated mineralogical bands with aligned hornblende. Throughout most of the Monte Guazú Complex the S1 foliation, trends NNW and dips ~45° to the northeast. The trend of the S1 foliation in the Conlara Complex is generally similar, however, the dip of the foliation is more variable due to locally intense reworking during subsequent events. No kinematic indicators where observed.

Sillimanite-garnet assemblages in pelitic gneiss indicate M1 metamorphism was at least amphibolite facies and abundant muscovite-pegmatites, and leucosome (forming subconcordant lenses with S1) suggest limited partial melting took place. Pressure-temperature (*P–T*) estimates of peak metamorphic conditions for rocks of the Monte Guazú

Complex in the Sierra de Comechingones range from 6.1 to 9.5 Kb, at 700 to 800°C (Cordillo, 1984; Martino and others, 1994; Cerredo, 1996).

No isotopic data exist from Sierras Comechingones to constrain the age of the Pampean Cycle. However, uranium-lead dating of zircon and monazite from Córdoba, further to the north, which grew during M1 in *Sierras de Septentrionales* (Lyons and Stuart-Smith, 1997), give an age of ~530 Ma (Camacho and Ireland, 1997). Late Pampean granites in Córdoba give an age of ~515-520 Ma (Camacho and Ireland, 1997; Rapela and Pankhurst, 1996; AGSO-Subsectretaría de Minería, unpublished data).

3.2 FAMATINIAN CYCLE

Ordovician deformation and metamorphism

In the early Ordovician a widespread deformation, metamorphic and magmatic event (the Famatinian Cycle) affected the southern Sierras Pampeanas. Numerous intrusives within the La Rioja area were emplaced around 490-480 Ma (Camacho and Ireland, 1997) and probably represent the core of the associated magmatic arc which developed at that time within a late Cambrian subduction/accretionarty Complex.

In gneiss and schist of the Conlara Complex, in particular those structurally beneath the Las Lajas Shear Zone, a schistosity parallel to S1 forms the main penetrative structure. Most S1 fabrics are rotated into parallelism with the S2 foliation which has a pronounced mineral lineation (L2) of biotite, muscovite and quartz. Lower amphibolite/upper greenschist facies metamorphism (M2) is indicated. Quartz-feldspar leucosome, formed during M1, are deformed into asymmetrical clasts indicating westward-directed thrusting. In places, the schistosity is axial plane to relict isoclinal folds (F2) which plunge parallel to the lineation. These folds are also present in Monte Guazú Complex gneiss, however, S2 development was limited.

3.3 ACHALIAN CYCLE

Devonian deformation and metamorphism

The Achalian deformation and magmatic cycle affected the southern Sierras Pampeanas where it was associated with widespread thrusting, retrogression and grantitic intrusion Characteristically, the deformation induced by east-west compression, involved repeated partitioning of strain between zones of strike-slip displacement and zones of thrusting, with repeated overprinting relationships. Domains between shearing were folded and refolded. In the area, two distinct styles of deformation are recognised:

1. thrusting at low-grade in discrete shear zones with penecontemporaeous folding and crenulation of the earlier formed mylonitic fabrics, and

2.brittle-ductile strike-slip faulting typically in conjugate sets trending generally NW and SW.

Thrusts and mylonitic zones

Throughout much of the region, medium-grade D1 and D2 fabric elements are rotated into parallelism by a shallowly- to moderately-dipping, penetrative D3 shear fabric associated with westerly-directed thrusting. This episode is marked by the development of mylonite in high-strain zones and pervasive, retrogressive greenschist-facies metamorphism. To varying degrees, this deformation affects all basement rocks in the region, including the Early Devonian Achiras Igneous Complex. Within the area zones of high-strain were focussed in a number of major mylonite zones, in particular, in the northwest-trending Las Lajas Shear Zone, which truncates the Conlara Complex north of Achiras.

Within mylonite zones, pelitic gneiss is of the Monte Guazú and Conlara Complexes are converted to schist or mylonite with a penetrative S3 spaced shear plane or mylonitic foliation of chlorite and sericite. Quartz is recrystallised to ribbons, biotite is deformed and replaced by chlorite, hematite and geothite, and M1 sillimanite is altered to fine muscovite aggregates. A mineral lineation (L3) or slickenline plunges down-dip to the ENE and is defined by aligned muscovite, chlorite, quartz and rotated relict biotite. Sheath folds are also present, in places, plunging parallel to L3. Kinematic indicators including, asymmetric mantled K-feldspar-quartz clasts and garnet augen, S-C-C' fabrics all indicate westward-directed trusting parallel to L3.

Although the D3 mylonitic fabric is most intense in the less competent pelitic gneiss, other rocks also form mylonite. In leucogranite within the Las Lajas Shear Zone, foliated metamorphic muscovite, rare relict primary biotite, and bands of granoblastic polygonal quartz and feldspar define S3. S-C fabrics are also common with a quartz-muscovite mineral lineation L3. Idioblastic garnet where present is altered to sericite.. In ortho-amphibolite, bands of recrystallised quartz, carbonate, plagioclase and epidote define a penetrative greenschist facies mylonitic foliation, and in pegmatite, S3 is present as recrystallised granoblastic polygonal bands of quartz and deformed muscovite folia.

Between high strain zones, S3 is present as either a spaced shear plane, or a crenulation which is axial plane to ENE-plunging tight to isoclinal folds (F3). The parallelism of these folds to L3 and the thrust direction strongly suggests that the non-coaxial character of the D3 deformation was widespread and not limited only to the mylonite zones. In these areas, D1 boudins of pegmatite, leucosome and amphibolite are flattened in S3 and stretched parallel to L3. Asymmetric S1 microlithons between S3 shear planes consistently indicate westward-directed thrusting.

The mylonitic fabric of the Las Lajas Shear Zone extends up to 1 km into the structurally underlying and overlying parts of the Conlara Complex. In areas further south (and structurally deeper), the main penetrative fabric is the medium-grade S2 foliation along which the Early Devonian subcordant granite sheets of the Achiras Igneous Complex were intruded. These layered granites are essentially undeformed, containing no penetrative tectonic foliations, and together with the metamorphics are folded about shallow N- to E-plunging regional open inclined to overturned macroscopic folds and mesoscopic chevron folding (F3). A weak axial plane crenulation (S3b) dips moderately to steeply (40-85°) to ENE. The same folds also occur throughout the Monte Guazú Complex and Las Lajas

Shear Zone, where they rotate the greenschist mylonitic fabric elements. As the folds are also truncated in part by the Las Lajas Shear Zone the folds most likely developed during the later stages of progressive westward-thrusting and mylonite formation.

Strike-slip faulting

A complex system of rectilinear brittle vertical WNW- and ENE-trending strike-slip faults, breccia zones and fractures displace the S3 mylonitic foliation and F4 folds. The faults are rarely exposed, but are prominenet on aerial photographs and Landsat images. Some of the faults are also delineated on magnetic images as low magnetic zones owing to magnetite destruction. One such fault is exposed in the extreme north near Cerro Morro (64.95113 °S, 33.01399 °W). Here a cataclasite over 20 m wide, separates the Conlara Complex from the structurally overlying Monte Guazú Complex and, blocks of the Achiras Igneous Complex are broken and highly altered by epidote, sericite, hematite and chlorite with rare geothite pseumorphs after pyrite.

The orientation and conjugate relationship of the WNW- and NE-trending strike-slip faults, breccia zones and fractures indicates possible continuation of the east-west compressive regime that accompanied S3 and S4 development. This fracture system is developed throughout the Sierras Pampeanas and in Córdoba and La Rioja Provinces where muscovite Ar-Ar ages of micas from quartz veins indicate that this stage began about 385 Ma, peaked at 370 Ma and continued until 355 Ma (Pieters and others, 1997; Lyons and others, 1997). The faults zones therefore represent the final stage of the Achalian Cycle.

3.4 ANDEAN CYCLE

Reverse faulting

During the Cainozoic, tectonism associated with the collision of the Nazca and South American plates resulted in a period of extensional deformation in the Sierras Pampeanas region in the Neogene, followed by compression from the late Neogene through to the present. The extensional phase resulted in volcanism and the development of a number of small southeast – northwest trending basins outside the sheet area.

A marked change in the regional stress field occurred after the mid-Pliocene, coincident with the cessation of volcanism. Since that time, the Sierras Pampeanas region has been in a compressional regime and the Sierras Comechingones are examples of the uplift on basement thrusts that have formed during this period (e.g. Costa and Vita-Frinzi, 1996). The ranges slope gently to the east and are bounded to the west by escarpments developed on low to moderate angle, east dipping, reverse faults. In the Sierra Comechingones, a major north-south fault zone, the Comechingones Fault (Costa and others, 1994), extends along the base of the western escarpment west of the **3366-24** sheet area. Carbon isotope ages (^{14}C) ages suggest the fault was active as recently as ~1000 years ago (Costa and Vita-Frinzi, 1996).

4. GEOMORPHOLOGY

The uplift during the Late Cainozoic of peneplanated crystalline basement on reverse faults, generally trending north-south, produced a series of tilt blocks throughout the Sierras Pampeanas (Jordan and Allmendinger, 1986). The asymmetry of the basement blocks is produced by the formation of steep escarpments on the bounding fault side and gentle slopes, the dissected peneplanated surface, on the other. Broad flat valleys between major blocks are depositional centres filled with a variety of Cainozoic and Quaternary sediments including aeolian, fluvial, and lacustrine material.

The region encompassing the sheet area is comprised of three main physiographic domains: the Sierras de San Luis in the west, the Sierra de Comechingones in the east, and the Conlara Valley in the centre which includes a number of minor ranges and the uplifted basement around the volcanic centre of Sierra del Morro. The principal faults along which uplift occurred are the San Luis and Comechingones Faults which dip to the east. The fault scarps are on the western side of the main sierras and the dissected peneplanated surfaces slope to the east. The broad depositional basin of the Conlara Valley contains the smaller tilt blocks of the Sierras de La Estanzuela, de Tilisarao, del Portezuelo, San Félipe, and del Yulto. The Sierra del Morro is a broad cone of uplifted basement resulting from the intrusion of the volcanic centre.

The Conlara Valley is filled with Cainozoic alluvial, aeolian, and volcanogenic deposits which preserve an earlier Cainozoic surface evidenced by the presence of palaeo-channels found away from present day watercourses. The intermontane deposits in the west of the sheet area are characterised by Quaternary gravels shed from the Sierras de San Luis.

The main drainage from the Sierras de San Luis is via the Río Quinto to the south east, which flows in to the Conlara Valley, and the Río Chorillos to the south west. The Sierras de Comechingones are drained by the east-south east flowing Río Cuarto. The Conlara Valley is drained by the north-north east flowing Río Conlara and the southward flowing Río Rosario.

5. GEOLOGICAL HISTORY

The **3366-24** sheet area forms part of the southern Sierras Pampeanas, comprising basement ranges of Neoproterozoic to early Palaeozoic metamorphic rocks and Palaeozoic granitoids, separated by intermontane Cainozoic sediments. The basement rocks form a series of north-trending lithological and structural domains separated by major mid-crustal shear zones. These domains have been variously interpreted to form originally part of an ensialic mobile belt (e.g. Dalla Salda, 1987) or as terranes that either accreted, or developed on a western convergent margin of the Rio Plata craton (e.g. Ramos, 1988; Demange and others, 1993; Escayola and others, 1996, Kraemer and others, 1995, 1996). Recent geochronological studies (e.g. Camacho and Ireland, 1997) indicate that there are two principal domains in the southern Sierras Pampeanas: an older Cambrian domain, and a younger Ordovician domain. Both domains share a common tectonic history since early Ordovician times. Only the older domain is present in the sheet area. The geological history of the sheet area is summarised in Table 2.

Table 2. Summary of the geological history of the **3366-24** sheet area. Age data and discussion of the various tectonic cycles are presented within the text. The ages of the Pampean Tectonic Cycle are derived from Lyons and others (1997).

Tectonic Cycle	Age (Ma)	Deposition	Deformation	Intrusion
Andean	present	Alluvial, and aeolian deposits.	Reverse faulting	
Achalian	~355 404		NW and NE conjugate strike-slip faulting Westerly-directed thrusting (Las Lajas Shear Zone), mylonitic foliation (S3), open folding (F3), retrogressive greenschist facies	Inti Huasi Granite, Achiras Igneous Complex (382 Ma)
Famatinian			Mylonitic S2 foliation isoclinal F2 folding, Lower amphibolite/ upper greenschist facies	
Pampean	515 530		Differentiated S1 foliation, isoclinal F1 folding, amphibolite facies	Minor tonalite and mafic rocks
	?540	Sediments of the Conlara and Monte Guazú Complexes		

5.1 EARLY CAMBRIAN SEDIMENTATION

The oldest rocks in the region form a structurally thick sequence of pelitic and lesser psammitic gniesses which comprise the Conlara and Monte Guazú Complexes. No original sedimentary structures, such as bedding, can be recognised in these metamorphic rocks. Carbonate-rich meta-sediments are common in the the Las Lajas Shear Zone and may represent extensions of similar domains in northern Cordoba (Lyons and others, 1997. These metasediments are interpreted as being deposited on a passive margin, developed during intracontinental rifting and breakup of Laurentia from Gondwana in Eocambrian times at about 540 Ma (Dalziel and others, 1994) in a tectonic environment similar to that envisaged by Dalla Salda and others (1992). Uranium-lead dating of detrital zircons in paragneisses from Córdoba. Lithological similarities and comparable ages indicate that the metasediments of the Monte Guazú and Conlara Complexes may be correlatives of the Early Cambrian (Aceñolaza and Toselli, 1981) Puncoviscana Formation in the northern Sierras Pampeanas. Such a correlation between the southern and northern Sierras pampeanas was first postulated by Willner and Miller (1986). The Puncoviscana Formation was interpreted by Dalla Salda and others (1992) to be related to the rift-drift transition during postcollisional Gondwana-Laurentia breakup.

5.2 PAMPEAN CYCLE

Early Cambrian Deformation, metamorphism, mafic and felsic intrusion

Following intrusion of minor tholeititic mafic dykes, the sediments were deformed at mid-crustal levels by a compressive event (D1) and metamorphosed at mostly upper amphibolite facies. Uranium-lead dating of zircon rims and monazite formed during this metamorphic event (M1) in Córdoba give an age of ~530 Ma (Lyons and others, 1997; Camacho and Ireland, 1997). This event includes both the D1 and D2 domains of Dalla Salda (1987) and has been previously termed the “Ciclo orogénico Pampeano” (Aceñolaza and Toselli, 1976) or “Ciclo Pampeano” (Dalla Salda, 1987, Toselli and others, 1992). The deformation is interpreted as the first in a series of deformation events associated with convergence on the newly created Pacific Gondwana margin formed after final amalgamation of the supercontinent (e.g. Dalziel and others, 1994).

At the closing stages of the Pampean Cycle, an extensive phase of felsic magmatism is evident by widespread subconcordant intrusion of tonalite, granodiorite and granite within the Monte Guazú and Conlara Complexes. There are no radiometric dates on these intrusions, however, in the Sierra Norte - Ascochinga area in Córdoba, similar intrusions are dated at ~515 Ma (AGSO-Subsecretaría de Minería, unpublished data).

5.3 FAMATINIAN CYCLE

Early Ordovician deformation, metamorphism, mafic and felsic intrusion

During the Ordovician, closure of the Iapetus Ocean and collision of the Precordillera with the Pampean margin of the Gondwana craton (Dalla Salda and others, 1992, 1996; Dalziel and others, 1996) resulted in amalgamation of the Cambro-Ordovician back arc and the Cambrain basement during a widespread deformational, metamorphic and magmatic event known as the “Ciclo orogénico Famatiniano” (Aceñolaza and Toselli, 1976), Famatinian Orogen (e.g. Dalla Salda and others, 1992) or “Ciclo Famatiniano” (Dalla Salda, 1987). A compressive deformation at mostly upper greenschist/ amphibolite facies, was accompanied by the development of east-dipping ductile shear-zones with, orthogonal westerly-directed thrust movement. Dalla Salda (1987) and Toselli and others (1992) ascribed this deformation (in the Córdoba region) to the D2 domain. Earlier D1 fabrics in the Monte Guazú and Conlara Complexes, in particular the latter, were openly to tightly folded and locally recrystallised to form a new foliation (S2).

5.4 ACHALIAN CYCLE

Early Devonian granite intrusion and deformation

Mid Palaeozoic resumption of convergence on the western margin of Gondwanaland is evidenced by a widespread compressive deformation in the Cambrian basement rocks, as well as the development of an Early Devonian magmatic arc. The deformation was dominated by orthogonal westerly-directed thrusting, with a component of sinistral shearing, both at greenschist facies, and the development of regionally extensive ductile and brittle-ductile, conjugate shear-zones. The Las Lajas Shear Zone developed at this time. Locally, outside the principal shear zones, the basement and cover rocks were open to isoclinally folded and refolded with an axial planar crenulation surface developed in places. Dalla Salda (1987) defined this deformation as D3, placing it in the "Ciclo Famatiniano", however, U-Pb and Ar-Ar data (Camacho and Ireland, 1997; Camacho, 1997) indicate this is a discrete event separated from the Famatinian cycle by at least 60 Ma.

Peraluminous to slightly peralkaline felsic melts, generated from partial melting of MgO depleted crustal rocks (Dalla Salda and others, 1995) intruded into the metamorphics discontinuously during and after shear zone development. The Las Lajas Shear Zone was the locus of multiply injected subconcordant granite and later pegmatite intrusion. To the east, the Inti Huasi Granite, a circular, zoned, and fractionated pluton crosscut the early, greenschist-facies shear-zones. Uranium-lead zircon dating of the Achalian granites suggests that initial plutonism was around 404 Ma (Camacho and Ireland, 1997). Ar-Ar ages from greenschist-facies mylonite zones suggests that deformation continued through till ~355 Ma (Camacho, 1997). The Achalian Cycle probably corresponds to the "Fase Precordillerânica" (Astini, 1996) in the precordillera west of the Sierras Pampeanas where it is related to the amalgamation of the Chilena terrane.

The final stages of the Achalian Cycle were marked by the province-wide development of a complex system of rectilinear brittle-ductile vertical NW- and NE-trending strike-slip faults and fractures. The orientation and conjugate relationship of the fractures indicates a continuation of the east-west compressive regime. In other areas of the Sierras Pampeanas these structures are locally associated with vein-type Au±Cu mineralisation, the result of mesothermal activity interpreted to be associated with the waning stages of magmatic arc activity as the centre of magmatic activity migrated westward (Ramos and others, 1986). Toselli and others (1996) attribute development of the fracture system to a 355 Ma old "Chánica Orogeny".

5.5 ANDEAN CYCLE

During the Cainozoic, east-west compression resulted in block thrusting of the basement rocks along the Comechingones Fault, west of the sheet, area to form the present north-south oriented range (Sierras de Comechingones). The range, like others in the Sierras Pampeanas is bounded to by escarpments developed on moderate to steeply-dipping reverse faults (Jordan and Allmendinger, 1986; Martino and others, 1995; Costa, 1996), many of which show a reactivated and long-lived history. Costa (1996)interpreted most significant movement in the region to have occurred during the Late Pliocene-Pleistocene with further movement continuing during the Quaternary.

ECONOMIC GEOLOGY

By Roger G. Skirrow

1. INTRODUCTION

The 3366-24 1:100 000 scale map area of Provincias de San Luis and Córdoba contains few known metallic mineral occurrences. The only located occurrences are for W and Ag-Pb-Zn, derived from the 1:750 000 scale map of Ricci (1974). The locational accuracy of occurrences from this data source is estimated as ±3000m. The region is, however, well endowed with marble which has been extracted in numerous quarries.

As part of the Geoscientific Mapping of the Sierras Pampeanas Cooperative Project, geological and resource data on mineral occurrences in the Sierras de San Luis and Comechingones regions have been compiled in a database (ARGMIN, in MicroSoft Access; Skirrow and Trudu, 1997) using a combination of data from the literature and field data. The principal deposits in most mining districts of the Project area were investigated in the field, with observations subsequently entered into the ARGROC and ARGMIN databases. Petrography of ore and host rock samples (thin sections and polished thin sections) was recorded in a petrographic database (Sims and others, 1996), and selected samples for ore genesis studies were analysed for whole rock geochemistry (Lyons and others, 1996; Lyons and Skirrow, 1996), stable isotopes of oxygen, hydrogen and sulfur (Lyons and Skirrow, 1996), as well as $^{40}Ar/^{39}Ar$ radiometric age dating (Camacho, 1997). Geographic coordinates were measured by GPS (locational accuracy ±50m), whereas those occurrences not visited in the field were generally located on airphotographs and their geographic coordinates digitised. The locational accuracy for photo-located occurrences is ±200 m. The locations of remaining occurrences are taken from the original data sources, which in some cases allow only very approximate geographic coordinates to be estimated (up to ±3000m).

Mineral occcurrence data are presented in the 1:100 000 scale Metallogenic Map. Output data sheets from the ARGMIN database are appended to this report. Further details on specific mineral deposits may be found in the database. A 1:250 000 Metallogenic Map for the sierras de San Luis and Comechingones shows the mineral occurrences in relation to prospectivity domains (Skirrow, 1997). The genesis of mineral deposits, metallogeny of the region and discussion of mineral prospectivity are presented in the Economic Geology section of the Report on 1:250 000 scale Geology of the sierras de San Luis and Comechingones (Sims and others, 1997). The principal geological, geophysical and metallogenic model coverages from the GIS of the Sierras Pampeanas (Butrovski, 1997) are presented in summary format (1:400 000 scale) in the *Atlas Metalogenético* (Skirrow and Johnston, 1997).

2. METALLIC MINERAL OCCURRENCES

2.1 W OCCURRENCES

Only one W occurrence has been located in the map area (Ricci, 1974), evidently within the Las Lajas shear zone or in marbles within this shear zone.

2.2 AG-PB-ZN OCCURRENCES

Two Ag-Pb-Zn occurrences were shown on the map of Ricci (1974) in this region of the Sierra de Comechingones, both apparently within the Monte Guazú Metamorphic Complex.

3. DIMENSION STONE

3.1 MARBLE

Numerous marble bodies within the Las Lajas shear zone have been quarried as sources of building stone and/or carbonate.

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ARGMIN

MINERAL DEPOSIT DATABASE

OUTPUT DATA SHEETS