Lower Ordovician volcanism in North West Argentina

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Outcrops of Lower Ordovician volcanic rocks occur over large areas of north west Argentina and are best studied in the regions of Famitina and Puna. In the former region the rocks vary from andesites to rhyolites in composition and form tuffs, lava flows and volcanic breccias. The main outcrops are found in the El Chuschin—Cuchilla Negra, El Cachiyuyo, Narvaez-Chaschuil and Les Planchadas. Volcanics occur in the Suri Fm. (s.l.), called locally the Morado and Las Planchadas formations. Lower levels contain Tetragraptus approximatus and upper levels Hoekaspis (= Merlinia) megacantha. The volcanics are therefore of Arenig age. In the Puna region the volcanics are mesosilicic and acid to alkaline forming lavas, often with pillows, tuffs, ignimbrites and spilites. In the Quichagua area the volcanic sequence is 600 m thick. Similar outcrops to the above occur in southern Bolivia and Peru.


Volcanic rocks and associated Ordovician sediments in north west Argentina were first known through the work of Stelzner (1885) who noted the occurrence of quartz porphyry and intercalated tuff in the Sistema de Famatina rocks then thought to be of Silurian age. Bodenbender (1916) recognised "interbedded diorites" in similar rocks and Penck (1920) described volcanites of "Devonian" age from the northern part of Famatina. Recent studies by Schwab (1973), Coira (1973), Koukarsky & Mirre (1974) at La Puna, and by Lavndaiho (1973) and Maisonave (1973) at Famatina, now consider the volcanic rocks and associated sediments to be of Ordovician age.

These studies, together with those of Aceñolaza & Toselli (1977), allow the recognition of major Ordovician volcanic events in north west Argentina and other parts of South America including Bolivia and Peru.

Ordovician Palaeogeography

In order to interpret the palaeogeographical situation of the Ordovician volcanic events it is convenient to take into account the structural framework in which the Ordovician basin in north west Argentina developed. The principal emergent areas in the west-central region of South America was the craton of Arequipa, made up of Precambrian crystalline rocks giving radiometric ages of between 600 and 1900 million years. This probably extended between the regions of Paracas in Peru and Antofagasta in Chile. In the east the continent was defined by the Dorsal or Cratogeno Central Argentino (Bracaccini 1960), consisting of igneous and low grade metamorphic rocks of Upper Precambrian to Lower Cambrian age (Aceñolaza & Toselli 1981), and by the Dorsal Charata-Asuncion of similar age and composition. The Dorsal Central Argentino formed a long wedge which divided the marine basin into the Cuenca de Pampasia on the east and the Cuenca de la Puna, Famatina and Precordillera (Cuyo) to the west.

In the Cuenca de Pampasia the sedimentological and palaeontological evidence suggests shelf conditions with deposition of fine and medium clastic sediments. In the Puna region the combination of turbidite facies and ophiolites indicates a deeper unstable basin with the formation of rhyolite-keratophyre-type volcanics adjacent to the shelf. In Famatina a shelf-slope
sequence with volcanics is present while in the Precordillera a shelf carbonate sequence grades into a flysch ophiolite facies along the western border (Baldis 1978).

Outcrops of volcanic rock
Outcrops of Ordovician volcanic rocks occur in several sections in north west Argentina extending from the Precordillera (33°S) to the border with Bolivia (22°S).

Puna of Salta and Jujuy areas
The studies of Schwab (1973), Coira (1973, 1975, 1979), Koukarsky & Mirre (1974) and Arganaraz et al. 1973) include detailed descriptions of the petrography of the Ordovician volcanic rocks in these areas. Spilite-keratophyre sequences are known in the Cochinoca-Escaya, Quichagua-Queta, Cauchari-Huaitiquina ranges and San Antonio de los Cobres, but one ophiolite is known from the Salar de Pocitos.

Quichagua-Queta and Cochinoca-Escaya ranges (66 00W—22 40 S)
Outcrops of Ordovician volcanic rocks in these ranges are almost continuous down their length. Although known for several decades, it is only from the recent studies of Coira (1973, 1975, 1979), that their composition and genetic aspects have been evaluated. These rocks are associated with a sequence of greywackes and shales (Formacion Acoite) of Arenig age and contain Didymograptus nitidus (see Steinmann & Hoek 1912), D. protobifidus and Tetragraptus fruticosus (see Aceñolaza 1981). Coira estimated the thickness of the Ordovician sedimentary sequence to be some 200 m consisting of grey-green greywackes interbedded with lavas, tuffs of spilitic, dacitic and rhyolitic composition.
Fig. 2. Summary of Lower Ordovician stratigraphy and vulcanology and occurrence of Arenig graptolites and trilobites.
Fig. 3. A, Map of north west Argentina and adjacent areas to show general Lower Ordovician palaeogeography. B, Cross section profiles along line A–B and C–D.
Coira (1979) calculated the volcanic rocks to be about 600 m thick in the Sierra Quichagua. The outcrops of Sierra de Queta and Cochinoca are similar with massive green coloured spilite horizons up to 18 m thick and ash flow tuffs and lava flows with a total thickness of 550 m.

In general terms the spilites are described as porphyry rocks. Coira (1979) distinguished two types of tuff, fine to pumice and thick tuffs rhyolitic to dacitic in composition. The ash flow tuffs and lava flows constitute well differentiated massive bodies.

Cauchari-Huaytiquina Ranges (67°00’W – 21°20’S)

These mountains are found to the west of Salar de Cauchari and extend to the Argentine–Chilean border. Schwab (1973) estimated the thickness of the Ordovician succession to be in the order of 3000 m of volcanics, cherts grey-wackes and shales, the latter containing the Arenig graptolites *Tetragraptus quadribrachiatus* and *Dichograptus octobrachiatu*s in the zone of Catua (Acenolaza & Durand 1975) and *Didymograptus* cf. *D. hincksii* in the Filo Tropapete. The volcanic rocks include diabases, diabase tuffs, porphyritic andesites and spilites.

San Antonio de Los Cobres (66°20’W – 24°20’S)

To the west and south west of San Antonio de los Cobres, Koukharsky & Mirre (1974) reported the occurrence of keratophyre tuffs near where Rolleri & Mingramm (1968) discovered Upper Arenig graptolites including *Didymograptus hirundo*.

Sistema de Famatina

The Sistema de Famatina includes a series of mountains extending from Llanos in La Rioja south to the Cordillera of San Buenaventura (27°25’S). Ordovician volcanic rocks occur in the zone of Las Planchadas-Chaschuil, Cerros Pabellon-La Ollita, Cachiuyuyo-Cerro Morado-Cuchilla Negra, el Chuschin-Miranda and el Mogote Plateado, and have been interpreted in a series of papers by Maisonneuve (1973, 1979) and Acenzola & Toselli (1977). The Las Plan-
Interpretation

We agree with Coira (1979) that the Puna spilit-karophytre sequence and associated sediments with graptolites, indicates a continental slope to basin facies belonging to an early orogenic suite. The presence of serpentinite bodies and gabbroic rocks in Salar de Pocitos, Vega del Cajero, Vega de Tamberias, Antofalla, Sierra de Calalaste and Filo de Copayo (Arganaraz et al. 1973; Allmendinger et al. 1982), are however associated with a later orogenic stage. Observations by Van Bemmelen (1963) and Souther (1967) on ash flow tuffs, indicate that these eruptions accompany periods of general elevation of the geanticline and related periods of strain and faulting. This stage coincides with the Farnatina event. In the Sistema de Famatina, the sediments indicate a shallow shelf environment associated with a synorogenic rhyolite suite of volcanic rocks.

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