FIRST LATE JURASSIC DINOSAUR BONES FROM CHILE

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Skeletal remains of dinosaurs from Chile are rare, unlike the ichnological record, which includes sauropods, theropods, and ornithopods, mostly from the Upper Jurassic-Lower Cretaceous (Moreno and Pino, 2002; Moreno et al., 2004). The first record of dinosaur bone in this country—a few remains of a titanosaur sauropod from the Upper Cretaceous of the Fourth (IV) Region—was reported by Casamiquela et al. (1969). Since then, the reported materials have been very scarce: only some titanosaur bones collected in the Upper Cretaceous of the Third (III) Region (Iriarte et al., 1999). Concerning their geographic distribution, most of the Chilean dinosaur remains occur north of 39° S Lat. (Salinas et al., 1991; Rubilar, 2003).

In this paper, an assemblage of dinosaur bones from the Central Patagonian Cordillera at Aysén (southern Chile; ca. 46° S), south of Lago General Carrera, is reported. Previous records of Jurassic dinosaurs of Chile consisted of footprints (Chong and Gasparini, 1976; Moreno and Rubilar, 1999). Thus, the remains from southern Chile are the first undisputed Jurassic dinosaurs found in this country, and the first significant remains of carnivorous dinosaurs, which previously were known only from isolated teeth found in the Upper Cretaceous Viñita Formation at the Monumento Natural Pichasca, in the Fourth (IV) Region (Rubilar, 2003).

Institutional Abbreviations—SNGM, Servicio Nacional de Geología y Minero, Santiago, Chile.

GEOLOGY

The fossils were collected from exposures of the Toqui Formation, which crops out in the mountains south of Lago General Carrera; the mountains are flanked by the Maitenes and Horquetas rivers (Fig. 1). The succession of clastic sedimentary rocks with intercalated tufts, locally bearing dinosaur bones, assigned to this unit is 300–320 m thick, with no exposed top. The dinosaur fossils occur in an approximately 100 m succession of alternating green volcanioclastic pebbly sandstones and sandy sedimentary breccias, with intercalations of lapilli tufts and red ignimbrites with eroded tops (Fig. 1). The base of the succession is a 20-m thick red ignimbrite. A Late Jurassic age was obtained from zircon samples extracted from this ignimbrite (see below).

The sandstones are coarse-grained, frequently passing into conglomerates. They are formed by fragments of andesites, rhyolites, dacites, basalts, quartzites, micaceous schists, plagioclase, quartz, and zircons. Two beds of fine-grained tuffaceous sandstones with abundant trace fossils include abundant detrital biotite. They probably represent reworked pyroclastic detritus. The sedimentary breccias are tuffaceous, with mainly volcanic clasts 2–8 mm in diameter, and isolated fragments up to 20 cm in diameter. The clasts are mainly volcanic in origin, including tuffs, volcanic breccias, and coherent andesite. The cement is calcite and locally chlorite and hematite or limonite. Glaucoline has been locally identified by X-ray diffractometry. These rocks experienced low-grade metamorphism of prehnite-pumpellyte facies.

Apart from the dinosaurs, other fossil material is rare. Locally, fossil tree trunks of Podocarpaceae and trilete spores occur, indicating humid and bleak conditions. Vertical and horizontal trace fossils (e.g., Thalassinoides) occur in two beds of medium to fine-grained tuffaceous sandstones. The vertical trace fossils are badly preserved; these are preliminary identified as Skolithos. These sedimentary beds resemble braided river deposits. However, the identification of glauconite in some of the green sandstones, and the occurrence of two tuffaceous sandstone layers with fossil traces of Thalassinoidea and probably Skolithos indicates marine sedimentation for those beds (see Frey, 1975; Ekdale et al., 1984; Goldring, 1991; Pemberton et al., 1992), at least. Therefore, the depositional setting of these beds is interpreted as that of a braided-river delta.

Underlying this facies association, north of the Las Horquetas river, an association of green conglomerates and tufts, with well-sorted dinosaur remains, is interpreted as a braided river deposit. Therefore, a change from braided rivers to deltaic environment is proposed for the dinosaur-bearing beds.

The dinosaur-bearing beds overlie a 30–50 m thick sandy-calcareous facies association, composed of calcareous laminites representing algal mats, minorstromatolite intercalations, and interbedded tuftites, tufts, and conglomerates. These rocks, in turn, overlie tufts of the Ibáñez Formation. The calcareous laminites represent peritidal deposits, which could be marine or lacustrine, although their relative proximity to shallow marine beds that they underlie, may favour a marine setting.

U-Pb SHRIMP Age

A new U-Pb SHRIMP age of 147 ± 1.0 Ma was obtained from zircon samples from the ignimbrite at the base of the measured section in Fig. 1. This corresponds to the Tithonian (Gradstein et