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AN EARLY DEVONIAN, EASTERN AMERICAS REALM FAUNULE FROM THE COAST OF SOUTHERN PERU

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ABSTRACT.—Unconformably above Precambrian rocks near Cocachacra, Peru, is a limited exposure of conglomerate and siliceous lutite. In the latter are the brachiopods *Acrospirifer* cf. *A. atlanticus* (Clarke, 1907), *Cupularostrum* cf. *C. macrocosta* (Boucot, 1973), *Atrypa* sp. and a possible isorthid. Other fossils include a gastropod, a bivalve and fenestellid bryozoans. This limited fauna suggests tentative correlation to Emsian age beds of the Floresta Formation of Colombia. The brachiopods show an apparent Eastern Americas Realm affinity and are unlike any reported from Malvinokaffric localities of the same age near Lake Titicaca (175 km distant). The Cocachacra fossils indicate a warm marine paleoenvironment, as contrasted to the much colder Malvinokaffric Realm to the east. Occurrence of an Early Devonian faunule on the Peruvian coast southwest of Arequipa provides the first indication of Eastern Americas Realm faunas south of Colombia.

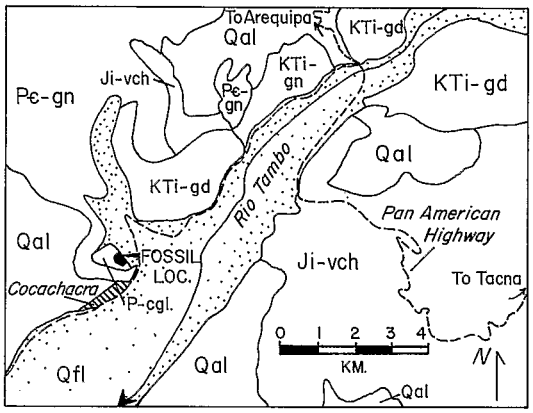
INTRODUCTION

ON the south coast of Peru (Text-fig. 1), 0.5 km northeast of Cocachacra (Text-fig. 2) and approximately 80 km southwest of Arequipa, fossils from a small exposure of Early Devonian strata provide valuable paleogeographic and biogeographic information for the Devonian Period. The Cocachacra Devonian is of unusual regional significance, because it provides the first suggestion that warm water Eastern Americas Realm faunas may have existed south of Colombia, Venezuela and the region in Brazil north of the Amazon River. Isaacson, Antelo & Boucot (1976) demonstrated that similarly cosmopolitan warm water faunas of Early Silurian (Llandovery) age in northwestern Argentina were bounded on the

GEOLOGY OF THE COCACHACRA LOCALITY

Devonian rocks near Cocachacra (Text-fig. 2) rest unconformably on metamorphosed and granitized shield rocks ("Complejo basal de la costa" of Bellido & Narvaez, 1960) of Precambrian age. The Precambrian here also includes a series of granulites dated as 2,000 m.y., which may have been reset at about 600 m.y. by the Brazilian Orogeny (Dalmayrac, Lancelot & Leyreloup, 1977). The Devonian is represented by a sedimentary sequence with a total thickness of less than 100 m (Bellido & Guevara, 1963; Paredes, 1964; independent observations by G. Laubacher and P. Isaacson). It consists of a lower, conglomeratic unit, the "Conglomerado Pocoma" of Bellido & Guevara (1963), overlain by an upper unit of

TEXT-FIG. 1—Location of the Cocachacra fossil locality on the southern Peru coastline.



TEXT-FIG. 2—Geologic map of the Cocachacra vicinity, Peru (*from* Bellido & Guevara, 1963). Pc-gn = Precambrian gneiss; P-cgl = Pocoma conglomerate; Ji-vch = Early Jurassic volcanics; KTi-gn = Cretaceous-Tertiary granitic intrusives; KTi-gd = granodioritic intrusives; Qal = alluvium; Qfl = river floodplain sediments.

the Pocoma Conglomerate and Cocachacra lutites, however, a Devonian age is possible for this unit. Conglomerates of pre-Devonian age, notably the Late Ordovician and Early Silurian Cancañiri and Zapla Formations (conglomerates) are known from other parts of the central Andes, and a correlation with these units cannot be demonstrated.

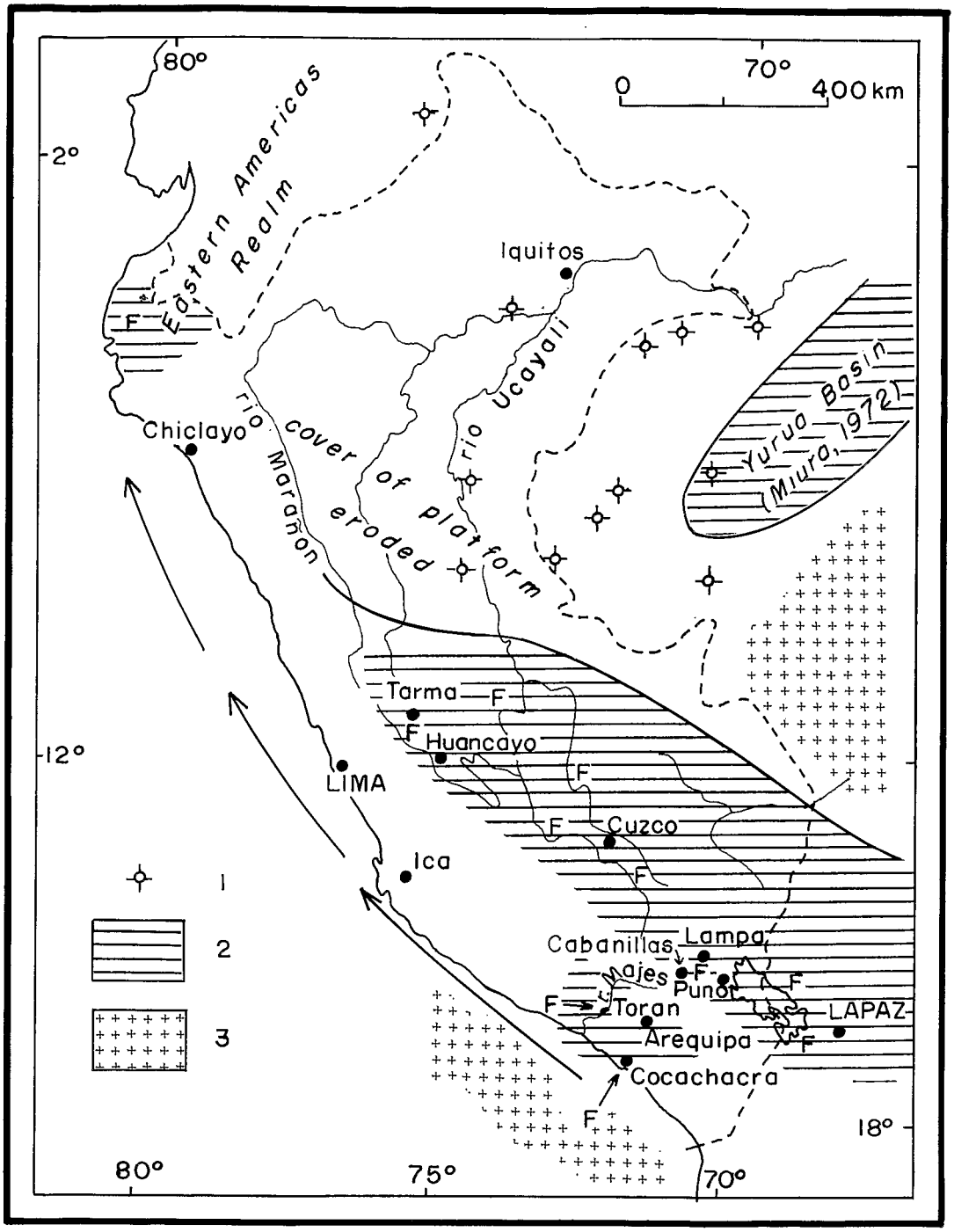
Above the conglomerate unit are quartzites and fine-grained, indurated and slabby beds of the Cocachacra lutites, which G. Laubacher estimates to be 30–40 m thick. These lutites might represent reworked, silicified volcanic material. In thin section, the fine- to medium-grained lutite contains abundant quartz as well as biotite and muscovite. The quartz grains are angular, and the grains are well-sorted, with very little fine-grained matrix. The rock also appears to be slightly feldspathic. The fossils occur in a dark brown, flinty siltstone, which weathers to a tan color. It has a siliceous cement. The fossils are mostly disarticulated and show no evidence of tectonic distortion.

The beds of Cocachacra lutite are well-stratified, and dip about 20–30° northeast in outcrop. The lutite beds average about 4–8 cm thick. Some fractures in the lutite are hematite-filled (particularly those parallel to bedding planes), and some are malachite-stained.

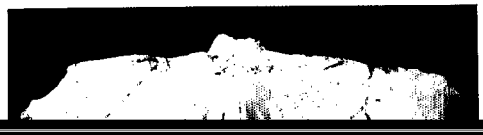
Tectonic setting.—Tilting of the Cocachacra Devonian beds is apparently not due to Hercynian folding *sensu lato,* but rather to Andean folding, during the Cretaceous and Tertiary. Folds, which include Devonian strata, strike NW–SE, and have an amplitude measured in kilometers. Schistosity and regional metamorphism are lacking.

Another locality in the southern Peru coastal range, where "Devonian" rocks are reported (Guizado Jol, 1968) is in the Rio Majes region, near Torán, Peru, 70 km northwest of Arequipa (shown in Text-fig. 3). The stratigraphic section there has 400 m of micaceous sandstone and mudstone (Torán Formation; see Paredes, 1964), with rare fossils. Paredes (1964) has suggested an absence of Hercynian folding in these rocks also.

In the entire coastal region of southern Peru only block faulting, giving rise to horsts and grabens, seems to have affected the area during the late Paleozoic. This block faulting has permitted the preservation of some fragments of the early Paleozoic beneath the existing, post-Paleozoic Andean cover rocks (Text-fig. 2). This has led Mégard et al. (1971) and Dalmayrac, Laubacher & Marocco (1977) to conclude that the Devonian rocks of the Peruvian south coast are part of a cover of a rigid Precambrian platform (Massif d'Arequipa) which forms the southwestern border of a subsiding Paleozoic basin of the central Andes.



TEXT-FIG. *3*—Distribution of the Devonian in Peru. *1*, boreholes through younger cover in the Subandean zone and the Brazilian Shield; *2*, regions where Devonian marine strata are known; *3*, regions which were probably emergent during the Devonian. F = Localities with known or reported Devonian fossils. Arrows indicate direction of warm water current which distributed Eastern Americas Realm faunas along Andean front.



It appears that an early Paleozoic land source area existed to the west of the present Andes (Isaacson, 1975; Boucot, 1975; Isaacson, Antelo & Boucot, 1976). Devonian lithofacies in the central Andean intracratonic basin (Isaacson, 1975) coarsen markedly, to the vicinity of Cabañillas, Peru (Text-fig. 3), where P. Isaacson in 1977 encountered basal fossiliferous Malvinokaffric beds of the coarsest lithology found anywhere in the Andean Devonian (some quartz clasts reach 1–2 cm in diameter). Between Cabañillas (28 km west of the Peruvian shoreline of Lake Titicaca) and the Pacific coast are Precambrian and Tertiary volcanic rocks (Laubacher, 1977). Fossiliferous Devonian rocks of the Cocachacra locality appear to be the only confirmed mid-Paleozoic rocks west of the general Cabañillas region, in southwestern Peru.

IMPLICATIONS OF THE COCACHACRA FAUNA

Occurrence.—Three collections have been made from the Cocachacra locality; that made by Aldo Rodriguez for Victor Benavides (which was dated as Devonian by G. A. Cooper in Paredes, 1964), one by G. Laubacher in 1972, and that made by P. Isaacson and colleagues in 1977. Table 1 lists fossils collected from the locality. The only reasonably abundant taxa are fenestellid bryozoans and an acrospiriferid with simple fold and sulcus. However, the geographic and stratigraphic position of the fossils necessitate that this important locality be noted. Paleozoic fossils are known from very few localities immediately bounding the Pacific coast of South America. As indicated by Boucot & Gray (1979) for the entire Paleozoic, and by Isaacson, Antelo & Boucot (1976) for the Silurian, it appears that the Paleozoic fossils in this Pacific bounding region are of warm-water type and biogeographic affinity, as contrasted to the more inland, cold-water, Malvinokaffric and Gondwanic Paleozoic units.

Age.—Fossils recovered from the Cocachacra Devonian locality (Text-figs. 1, 2) are shown in Pl. 1. Age of the fossils is difficult to determine. The most abundant brachiopod is a large acrospiriferid with simple plications and an unmodified fold and sulcus. The shell is considerably larger than any of the simple spiriferids present in the Silurian and early Lower Devonian. Shells of this size and morphology are first known elsewhere in about late Lower Devonian (Siegenian and Emsian) time. A single specimen of coarsely plicate atrypid brachiopod is important for age determination. Atrypid brachiopods possessing coarse plications are known from the Late Ordovician (Ashgillian) through Late Devonian (Frasnian). Presence of the atrypid with the spiriferid brackets the age of the Cocachacra locality as Siegenian (or Emsian) to Frasnian. The other fossils are more difficult to identify and to correlate with certainty. A single specimen of a medium-sized spiriferid

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EXPLANATION OF PLATE 1

FIGS. *1–6*—*Acrospirifer* cf. *A. atlanticus* (Clarke, 1907). *1,* impression of interior of pedicle valve (×1.5), USNM 264350; *2,* impression of interior of brachial valve (×1.5), USNM 264350; *3,* impression of interior of brachial valve (×1.5), USNM 264351; *4,* impression of interior of brachial valve (×1.5), USNM 264351, note the presence of short crural plates; *5,* impression of interior of pedicle valve (×1.5), USNM 264352. Note the form of the muscle field and of the sulcus. *6,* impression of exterior of pedicle valve (×1), USNM 264353, note the form of the sulcus and of the lateral plications.

7–8—*Cupularostrum* cf. *C. macrocosta* Boucot, 1973. *7,* impression of interior of pedicle valve (×1.25), USNM 264354; *8,* impression of interior of brachial valve (×1.5), USNM 264355, note the length of the median septum.

9—"*Spirifer*" cf. "*S.*" *kingi* (Caster, 1938). Impression of interior of pedicle valve (×1.25), note the form of the lateral plications, of the bifurcating plications, and the presence of plications in the sulcus, USNM 264356.

10—*Atrypa* sp. Impression of interior of pedicle valve (×4), USNM 264357, note the short dental lamellae.

11—isorthid? Impression of interior of pedicle valve (×1.25), USNM 264358.

12–14—Fenestellid bryozoans. *12,* impression of fenestellid bryozoan (×4), USNM 264359; *13,* impression of fenestellid bryozoan (×2), USNM 264360; *14,* impression of fenestellid bryozoan (×3), USNM 264361.

TABLE 1—Macrofossils recovered form the Cocachacra lutite (number of specimens).

	Rodriguez collection	Laubacher collection	Isaacson collection
Acrospirifer cf. *A. atlanticus* (Clarke, 1907)	5	6	40
Cupularostrum cf. *C. macrocosta* Boucot, 1973	2	0	4
"*Spirifer*" cf. "*S.*" *kingi* (Caster, 1938)	0	1	0
Atrypa sp.	0	1	0
isorthid? sp.	1	0	0
bivalve?	1	1	3
gastropod			
fenestellid bryozoans			

with plicate sulcus is similar to "*Spirifer*" *kingi* of the Floresta Formation fauna described by Caster (1938) from the Colombian Devonian. However, the single Cocachacra specimen forms a basis for tentative correlation only. The rhynchonellid from Cocachacra is similar in form to *Cupularostrum macrocosta,* which is common in Schoharie age (Emsian) faunas from the Eastern Americas Realm (see Boucot, 1973, for specific description). A single pedicle valve of a large dalmanellid is difficult to as-

rocks by E. J. Cobbing and colleagues in 1978 yielded no further fossils. From the same area, Paredes (1964, p. 17) reports that V. Benavides identified *Mesoconularia ulrichana* Clarke, *Tentaculites jaculus* Clarke? and *Paleoneilo* cf. *P. pondeana* Hartt. This collection is suggestive of a Devonian age, as well as Malvinokaffric, cold-water fauna affinities. Conularids are abundant in Malvinokaffric Realm Devonian rocks.

Boucot & Gray (1979) suggest that a surface

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Laubacher and Isaacson are responsible for the geologic information presented herein; Boucot interpreted the brachiopod information. All of us are responsible for interpretation of the regional significance of the fossils and the rocks that contain them.

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