SELECTED ASPECTS OF THE GENERAL GEOLOGY AND ENGINEERING GEOLOGY ALONG THE ROADS TO ENSENADA, BAJA CALIFORNIA NORTE, MEXICO

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Leighton and Associates, Inc.

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ALONG THE ROADS TO ENSENADA, BAJA CALIFORNIA NORTE, MEXICO

INTRODUCTION

The relatively undeveloped areas along the Ensenada highways (libre and cuota) afford us a somewhat clearer perspective on coastal geology as compared to the metropolitan region north of the border. However, we will find that the geologic conditions to the south are, in some respects, quite different than those of San Diego. Also, the interpretation of the geology and geomorphology is somewhat more problematic owing to the complex interactions of major landslides, marine terraces, erosion rates, and Quaternary faults. The 1986 San Diego Association of Geologists field trip will focus upon some of the current, albeit on-going studies, that some of our members are conducting. Several figures are attached following the rear of the text for your reference in conjunction with the following abstracts.

STOP NO. 1 - LA JOYA TURNOFF (Tom Deméré, Speaker)

La Joya - Rosarito Beach Formation; San Diego Formation

La Joya turnoff, east side of toll road. At this site the unconformable contact between the Costa Azul Member of the Rosarito Beach Formation and the San Diego Formation is well exposed in several roadcuts. The base of the section here is marked by a 10-meter thick, gray to pink, vitric tuff overlain by 8 meters of black, porphyroaphanitic, olivine basalt. The contact between the tuff and basalt is characterized by a bright pink baked zone. Hawkins (1970) gives a K-Ar date of 14.3 +/- 2.6 mya for a basalt near this locality.

Overlying the volcanic rocks of the Costa Azul Member are fossiliferous marine sandstones of the San Diego Formation. Ashby and Minch (1984) described this section and provided a faunal list of the marine invertebrate and vertebrate fossils found here. The base of the San Diego Formation at La Joya consists of a richly fossiliferous cobble conglomerate containing abundant shells of the Late Pliocene scallop, Pationopecten healeyi. Molluscan taxa with calcitic shells dominate the assemblage while most aragonitic taxa are leached or broken. Poorly preserved fragmentary remains of fossil marine mammals also occur in this basal conglomerate along with rare well-preserved teeth of several species of sharks. Overlying the conglomerate is some 43 meters of massive and locally channeled very fine-grained, micaceous arkosic sandstone. This sequence is locally fossiliferous. The entire section can be viewed by walking the sewer access road which runs up the hill.

To the east, the San Diego Formation apparently on laps a monoclinal fold in the Miocene volcanic rocks. Further east in the core of this fold, the sandy-matrix breccia facies of the Mira Al Mar Member of the Rosarito Beach Formation is exposed. These exposures can be reached by walking east along the sewer access road on the ridge line and then descending into the steep walled canyon to the south.

STOP NO. 2 - SAN ANTONIO DEL MAR (Bob Dowlen, Speaker)

Soil and Geologic Hazards at San Antonio Del Mar, Baja California Del Norte, Mexico - A Case History

San Antonio Del Mar, a private resort community catering primarily to American investors, is located along a 2-mile stretch of Pacific seacoast approximately 9 miles south of the international border at San Diego, California. The resort was developed in the early 1970's atop seacliffs composed of a thin veneer of late Pleistocene marine terrace deposits that are underlain by basaltic lava flows within the Miocene Rosarito Beach Formation. The coastline at the site and general area is composed of rocky headlands, cove beaches, and near-vertical sea cliffs that average approximately 50 feet in height.

Site development was performed without the apparent aid of geotechnical expertise and consisted of uncontrolled mass grading that created a variety of cut and fill building pads and associated slopes. Residential construction was performed on an individual basis as 30 year trusts were purchased and largely utilized locally available adobe brick and masonry block building materials.

A review of vertical photographs, topographic maps, and limited shallow refraction seismograph data indicated that westerly draining arroyos were filled, and at least one cove beach was extended seaward by as much as 250 feet by the construction of a 50-feet high, 1-to-1 fill slope. As a result, many homes built on fill soils have experienced structural distress ranging from "livable" settlements to others that have been abandoned. Several bluff-top houses have also been destroyed as a result of wave attack and subsequent fill slope retreat. Due to these problems, the developers are now "encouraging" potential lessees to seek geotechnical consultation prior to building.

STOP NO. 3 - LOS ALISITOS (David Schug, Speaker)

"Coastal Faults and Marine Terraces"

Based on geologic mapping by Gastil and others (1975), the coastal area along our route (generally extending northerly from Punta Salsipuedes to the Alisitos-La Fonda area) is traversed by a series of north- to northwest-trending faults that extend inland about 7.5 km (4.5 mi). These coastal faults are subparallel to the complex and broad fault zones mapped in the immediate offshore area (Legg and Kennedy, 1979). Virtually all of the faults within the Coronado Banks fault zone (extending across the Coronado Shelf and the region offshore from Punta Descanso) have been interpreted to displace late Pleistocene and locally Holocene sediment. The immediate offshore region is also characterized by moderate levels of historical seismicity. At Punta Salsipuedes and inland, several small magnitude earthquake epicenters appear to correspond with mapped fault locations. Many of the coastal faults are also expressed by prominent landforms (scarps, sag ponds, and offset drainages?). As yet, few, if any, studies have been made relative to their recency, rates, and continuity. Perhaps further evaluation of the coastal faults in the vicinity of Punta Salsipuedes may yield important information on seismic hazards in the nearby offshore region. Also, an understanding of the characteristics of these coastal faults is necessary to evaluate landslide potential, for as we will see at Punta Salsipuedes, the areal distribution of the many major coastal landslides appears to be influenced by the orientation of faults and pervasive fractures.

At the Alisitos stop, we will explore (and discuss) a "youthful," north-trending fault that clearly displaces the lowest emergent marine terrace. The first marine terrace at Alisitos has been correlated (Kennedy and others, 1986) with the warm-water phase of the last interglacial period of about 125,000 years ago (oxygen isotope substage 5e). Pleistocene marine invertebrate faunas, composed predominantly of mollusks, are not uncommon on the low emergent terraces of northwestern Baja California, but were previously unreported from a 80-km stretch from Punta Descanso to Punta China. Molluscan faunas from the first emergent terrace at Alisitos-La Fonda were dated by an amino-acid racemization method and are shown to correlate with U-series dated terrace sequences in southern California and outer Baja California Sur (Kennedy and others, 1986).

STOP NO. 4 - PUNTA SALSIPUEDES (Tom Kuper, Speaker)

Mega-Landsliding (or "Get Out If You Can!")

A large portion of the Baja California coastline between Tijuana and Ensenada is subject to landsliding. Potentials for sliding are enhanced by a lithic situation consisting of weak marine sediments overlain by thick basalts. Immediate causes of landsliding are the steepening of slopes by the sea and large rivers. Urban and resort development in these areas in the future may aggravate these potential slide conditions.

The thick sequence of easily eroded sediments capped by a resistant basalt is the basic underlying cause of the landsliding in the coastal area. The sea, or a major river channel, is able to remove the soft sediments from the base of the slopes which causes over-steepening. Failure finally occurs when the slope is no longer able to support the capping basalts. The faulting and master joints in the area control the distribution of the slides to an extent yet to be determined. The areas where the cliffs are parallel to one or more joint systems and the finely laminated Cretaceous Rosario Formation are more likely to slide. Other areas are along the major stream valleys which have cut deeply into the weak Rosario sediments. Many areas contain multiple landslides.

STOP NO. 5 - PUNTA SAN MIGUEL (Bob Dowlen, Speaker)

"Deslizamiento de Abulón"

The turnout at San Miguel permits a relatively safe vantage point to observe one of many active landslides that jeopardizes Ensenada cuota (as well as several hillside residences). Continued movement of this slide, like many others between Punta Salsipuedes and San Miguel, has necessitated frequent repair of the highway. Frequent highway travelers report that during rainy periods, large crevices and chasms are not uncommon on this stretch of the highway. Mitigating measures undertaken for the landslide at San Miguel include slope flattening and removal of landslide materials, efforts to provide a buttress at the landslide toe and installation of inclinometers.

STOP NO. 6 - RAULS

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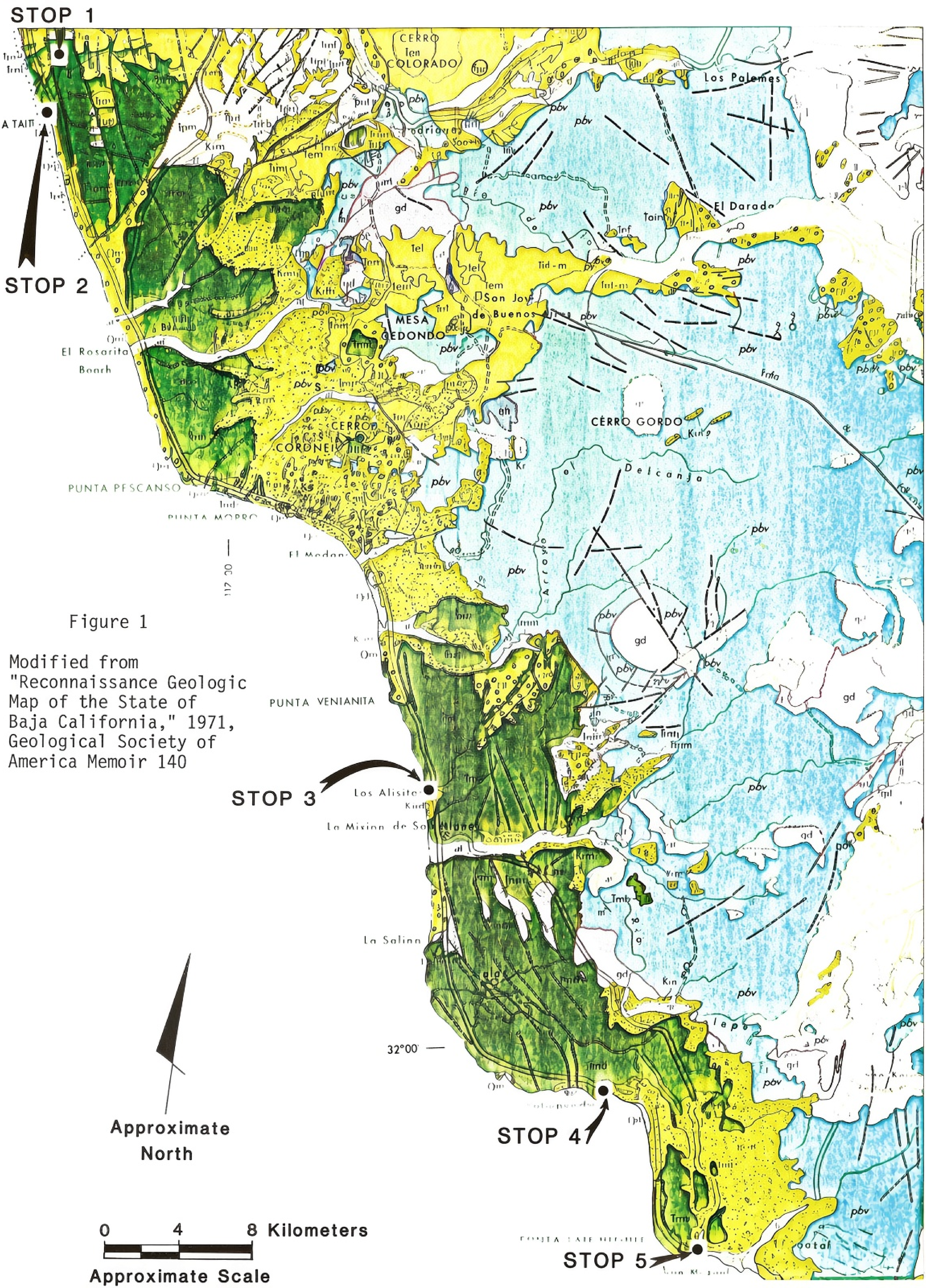


Figure 1

Modified from "Reconnaissance Geologic Map of the State of Baja California," 1971, Geological Society of America Memoir 140

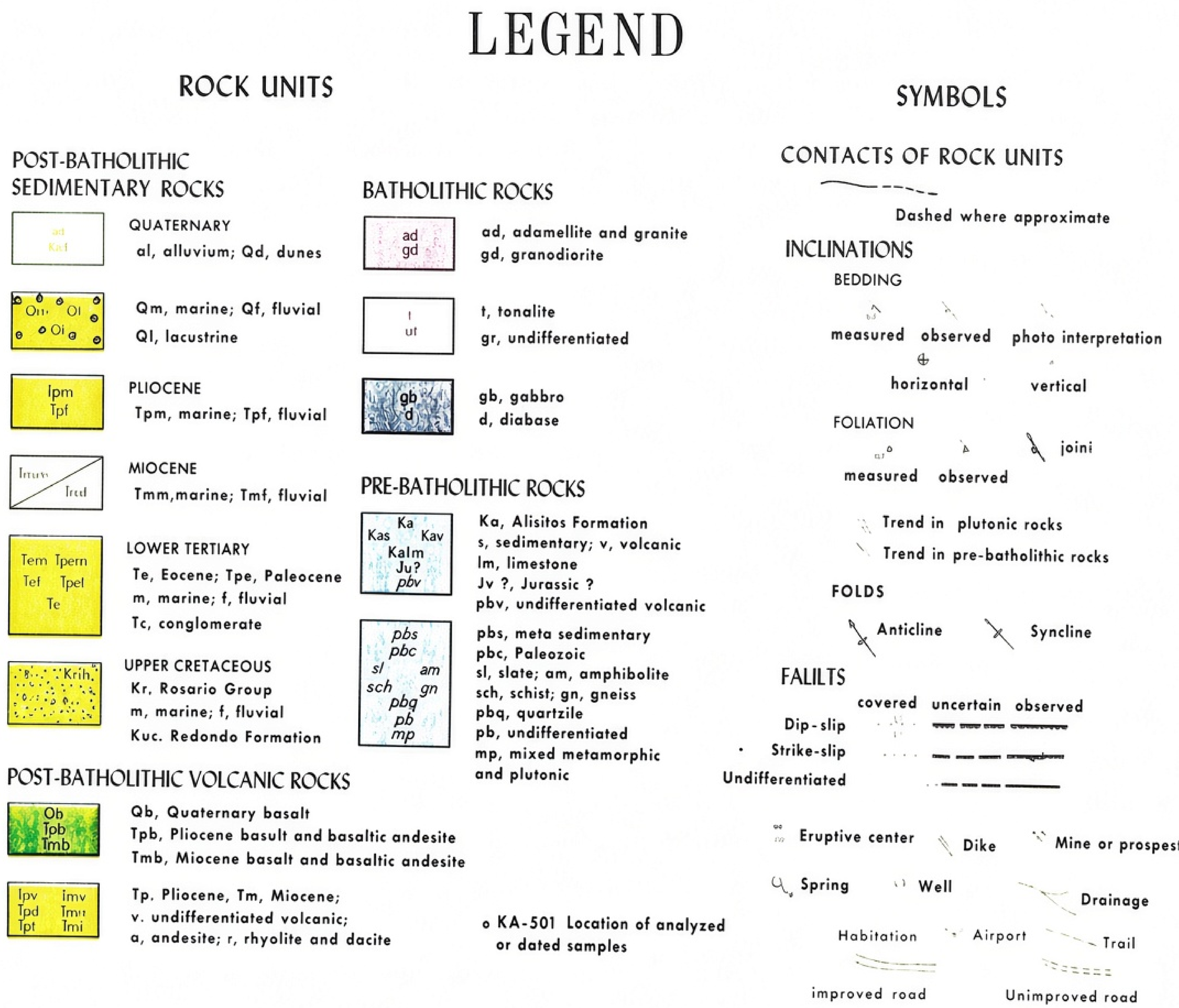


Figure 2

Modified from
"Reconnaissance Geologic Map of the State of Baja California," 1971, Geological Society of America Memoir 140

CORRELATION CHART

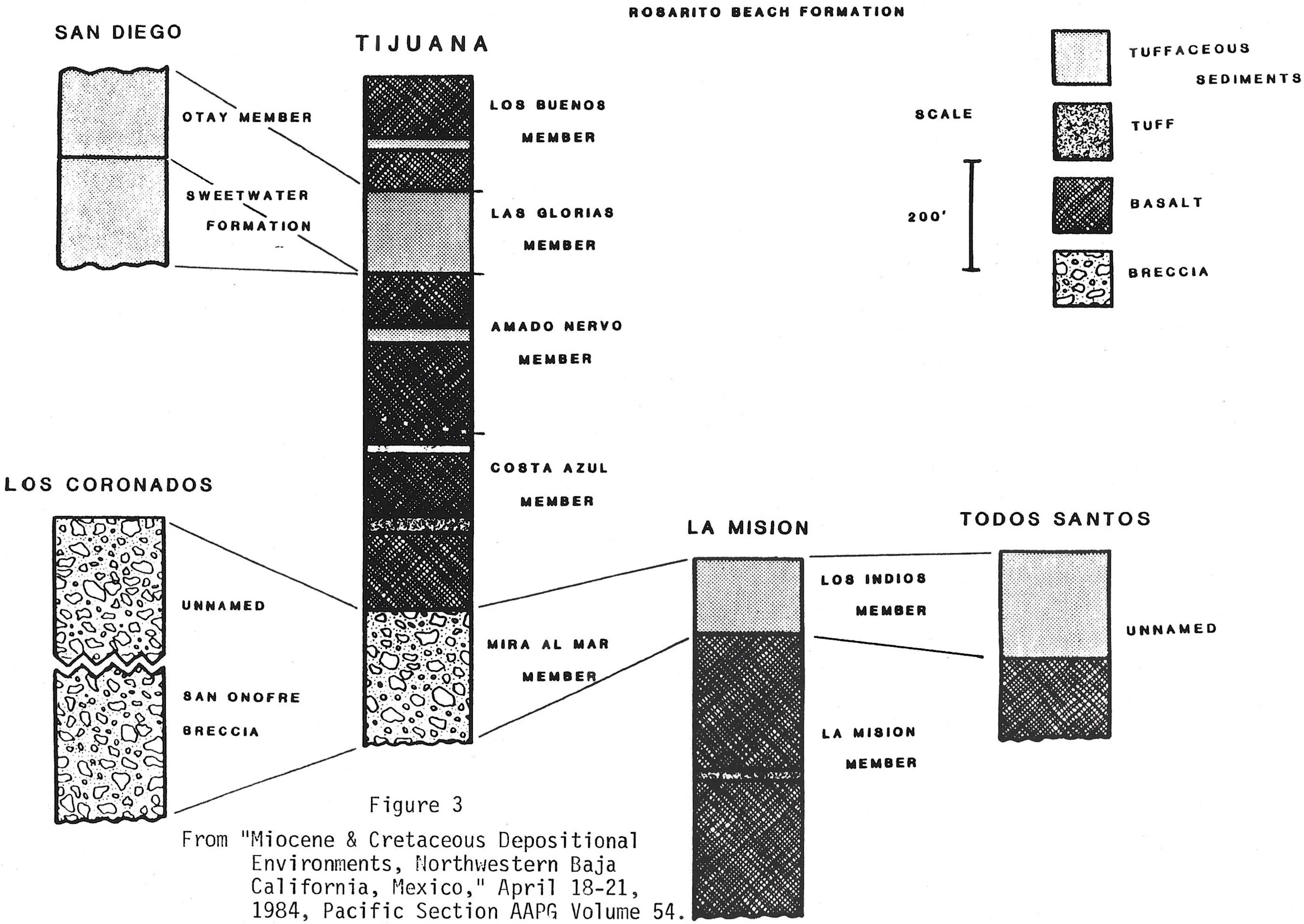


Figure 3

From "Miocene & Cretaceous Depositional Environments, Northwestern Baja California, Mexico," April 18-21, 1984, Pacific Section AAPG Volume 54.

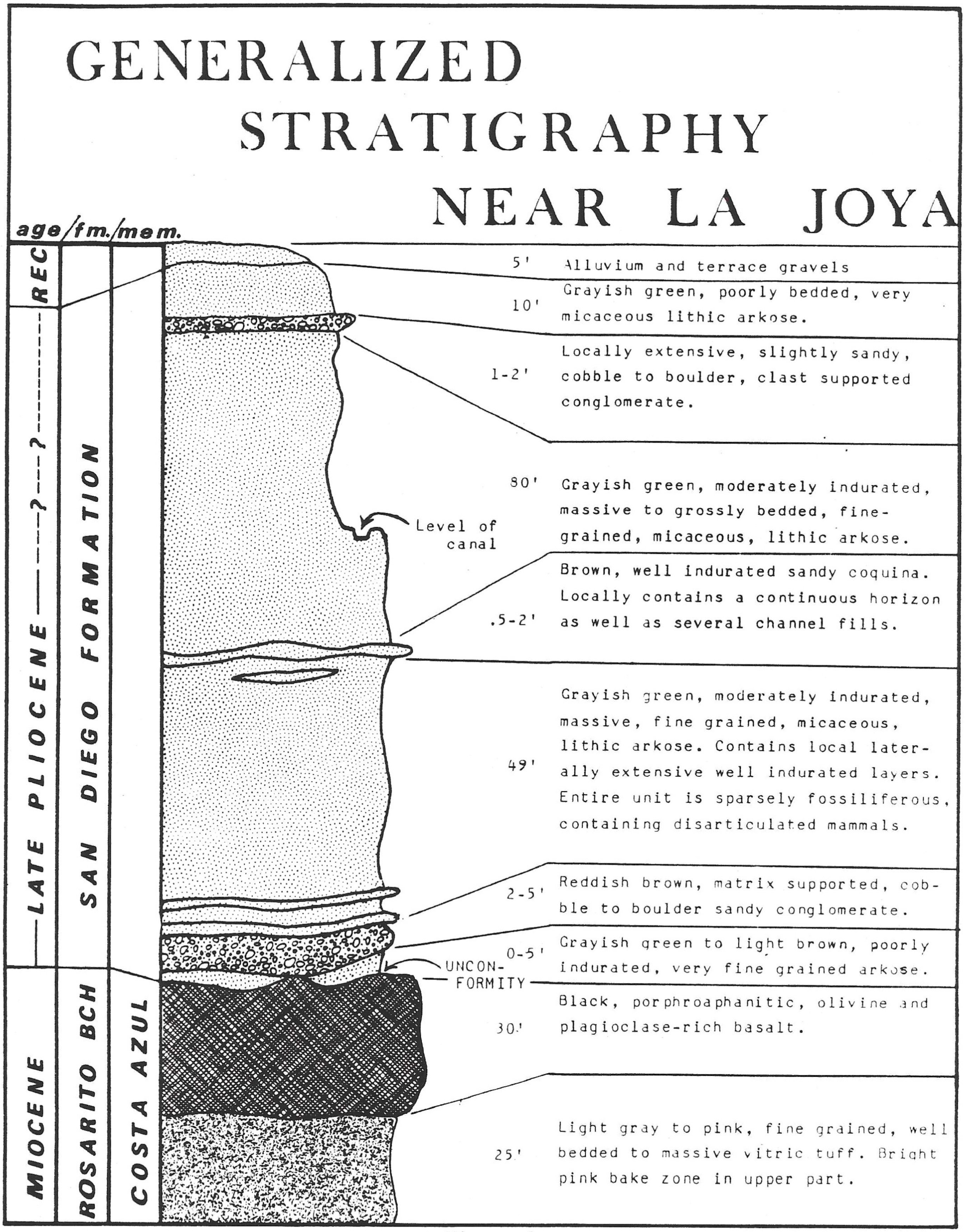
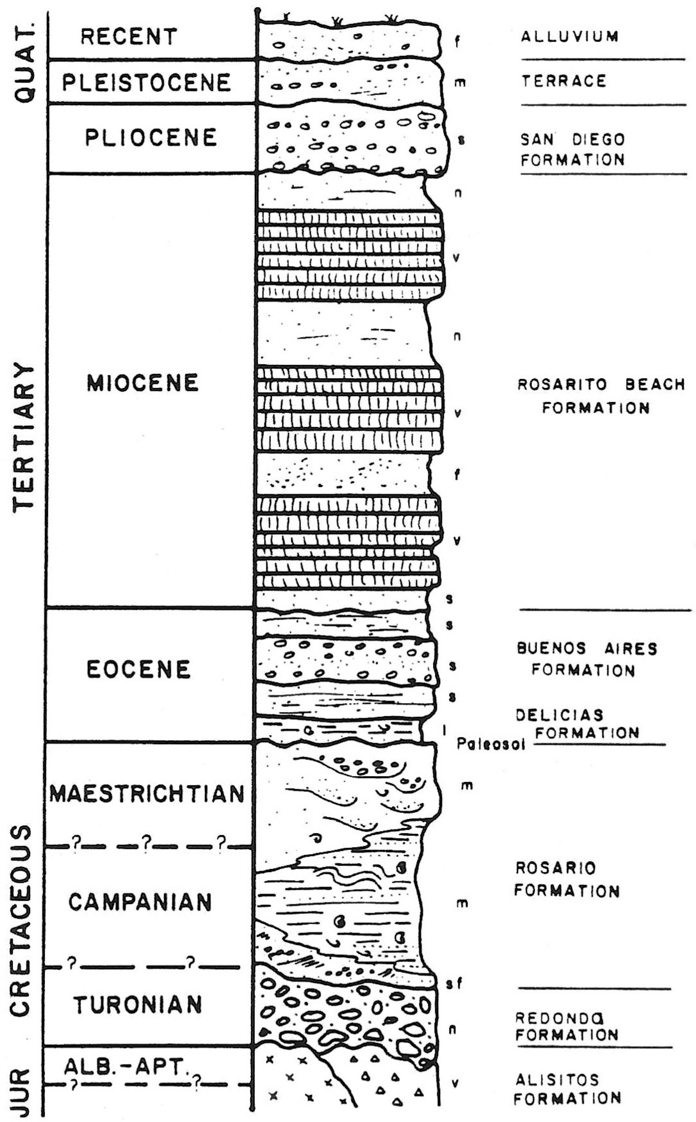


Figure 4

From "Miocene & Cretaceous Depositional Environments, Northwestern Baja California, Mexico," April 18-21, 1984, Pacific Section AAPG Volume 54.



General stratigraphy of northwestern Baja California (modified from Minch, 1967).

Figure 5

From "Miocene & Cretaceous Depositional Environments, Northwestern Baja California, Mexico," April 18-21, 1984, Pacific Section AAPG Volume 54.

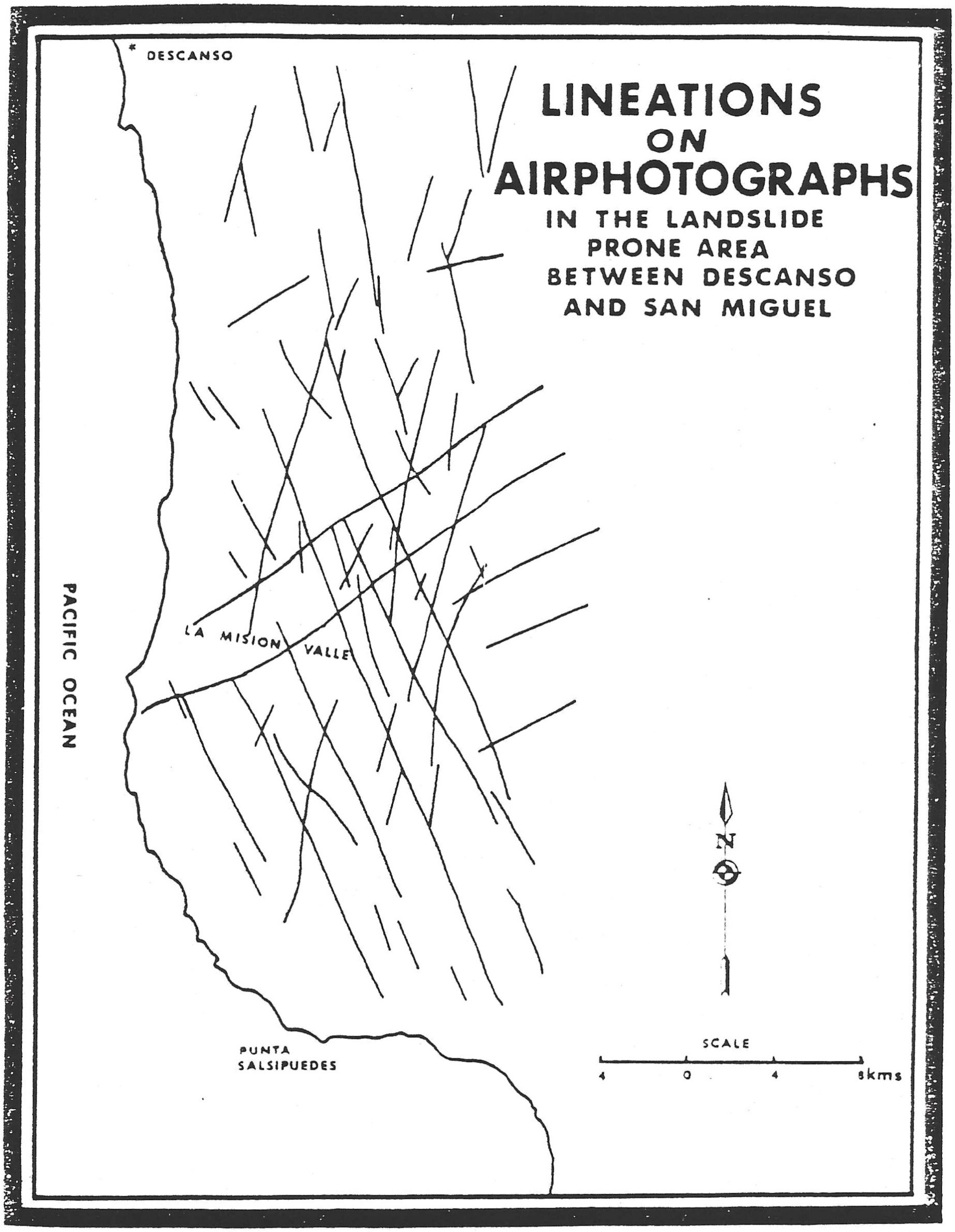


Figure 6

From "Landsliding and the Effects of Resort Development between Tijuana and Ensenada, Baja California, Mexico," 1972, Technical Report 0-72-1, Office of Naval Research, Contract No. N00014-69-A-0200-5003.

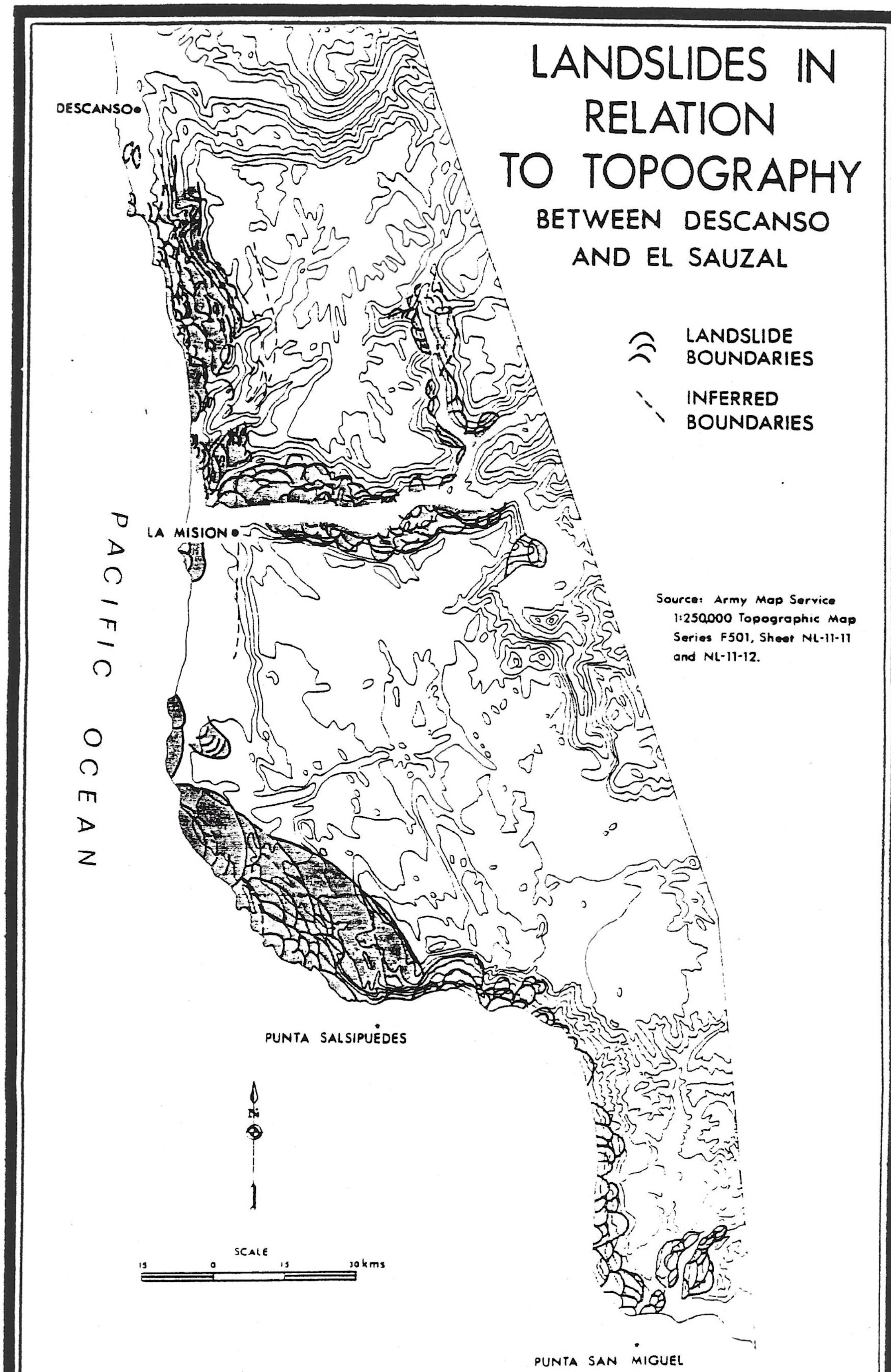


Figure 7

From "Landsliding and the Effects of Resort Development between Tijuana and Ensenada, Baja California, Mexico," 1972, Technical Report 0-72-1, Office of Naval Research, Contract No. N00014-69-A-0200-5003.