Marine and continental assemblages from San Gregorio Formation
(Late Oligocene – Early Miocene), La Bocana Region, Baja California
Sur, Mexico

Elia Ramírez-Arriaga¹, Mercedes B. Prámparo², G. Raquel Guerstein³, Enrique
Martínez-Hernández¹, Iris G. Galván-Escobedo¹, Rodolfo Corona-Esquível⁴⁵,
A.J. Marmolejo-Rodríguez⁶

INTRODUCTION

Palynostratigraphy allows studying microfossils such as pollen, spores, dinocysts,
acritarchs, between others palynomorphs that had been preserved throughout geologic
time in marine and continental sedimentary rocks. Moreover, it is possible correlating
terrestrial with marine deposits by mean of palynomorphs of chronostratigraphic
importance. The impact of stratigraphic palynology is due to valuable potential to solve
paleoenvironmental, paleoclimatic and geologic problems based on paleopalynological
assemblages’ analysis, in order to reconstruct and analyze origin, migrations and
distribution of different taxa (Graham, 1999; Jansonious y McGregor, 1996; Traverse,
2007).
The present project DGAPA-PAPIIT-105411 focuses on the well preserved
palynological assemblages recovered from San Gregorio Formation, including both
marine and continental microfossils. Based on quantitative analysis it is possible to
propose paloenvironmental models related to the distribution patterns of marine
palynomorphs. On the other hand, pollen and spores assemblages reflect the
composition of plant communities evolved near the depositional area. Both marine and
continental palynomorphs provide information about paleoclimatic changes as well as
biostratigraphic data that will be important for future correlations.

GEOLOGICAL SETTINGS
San Gregorio Formation was deposited when Baja California was part of a stable shelf
and it was attached to the Mexican mainland (Hausback, 1984). This formation lies
unconformably on the Tepetate Formation, assigned to the late Cretaceous to Eocene.
The stratigraphy of San Gregorio Formation is characterized by a lower member
composed of shales, sandy shales with interbedded sandstones, siltstones and fine-
grained compact, of sandstones presenting alteration by silicification. The upper
member is composed of silicified black shales, sandstones with concretions and thin
bands of chert.
According to radiometric dating, micro and macrofossils information, the age of the San
Gregorio Formation has been considered Late Oligocene – Early Miocene (Gastil et al.,

Methodology
A total of 116 samples from one borehole (depth of 153 m) have been used for the
paleopalynological study. All samples were processed using HCl, HF and Erdtman’s
acetylosis method. Besides, the organic material was recovered by density and using
BrZn₂. Determinations and palynomorph countings were made using a ZEISS Axiolab
microscope. An AxioCam digital camera and Axiovision image capturing software were
used for palynomorph photography. Pollen and dinocyst identifications were made by
comparison using special literature. Some information about botanical affinity, ecological requirements of plant communities as well as recent distribution were included.

**PRELIMINARY RESULTS**

**Continental assemblages**

Pollen palynomorphs represent a mixture of local and regional vegetation growing in the mainland, under particular microclimatic regimes toward an altitudinal gradient from the coastal plain to the volcanic mountain ranges that are part of the Sierra Madre Occidental.

**Temperate communities**

Pollen assemblages give evidence of regional temperate vegetation integrated by *Pinus* forest and cloud forest. Paleocomunities of *Pinus* forest and cloud forest have been reported since the late Eocene to the early Oligocene at Cuayuca and Pie de Vaca Formations, two basins located in the state of Puebla (Martínez-Hernández and Ramírez-Arriaga, 1999; Ramírez-Arriaga et al., 2006, 2008). Currently, the *Pinus* forest grows at 914 - 4,000 m of altitude (Miranda, 1947, Valiente-Banuet et al., 2000).

Cloud forest has been also registered in Tertiary basins southern of Mexico (Martínez-Hernández and Ramírez-Arriaga, 1999; Ramírez-Arriaga et al., 2006, 2008). Mexican cloud forests are found on humid and temperate areas, it has high diversity of trees, besides it exhibits predominance of epiphytes and lianas. The floristic elements are a) temperate trees, b) neotropical herbs, epiphytes and shrubs and c) endemic plants. Actually, their distribution follows a fragmented pattern. In the “Sierra Madre Occidental”, it is more frequent between 1800 and 2600 m of elevation.

**Tropical dry forest**

The palynostratigraphic fossil records allowed a knowledge of tropical dry forests which could have been very extensive since Paleogene, as it has been well documented in continental basins such as Pie de Vaca Formation and Cuayuca Formation of upper Eocene to lower Oligocene (Ramírez-Arriaga, 2005; Martínez-Hernández and Ramírez-Arriaga, 2006; Ramírez-Arriaga et al., 2006, 2008). Some taxa that belong to this plant community were Acacia, Bursera, Euphorbiaceae and Leguminosae. At present, tropical dry forest is one of the most important types of vegetation extensively distributed from sub humid to semiarid climate in Mexico (Vázquez, 1999; Becerra, 2005). This plant community is characterized by trees 10 m high growing at slopes (Valiente-Banuet et al., 2000) and is dominated by legumes and Burseraceae (Becerra, 2005).

**Grassland and thorn forest**

Local semiarid conditions probably allowed the development of grassland, under this arid regime with seasonal rainfall, Amaranthaceae-Chenopodiaceae, Gramineae and *Ephedra* were abundant. Additionally, neighboring communities for instance tropical dry forest was developed.

Studies by Frederiksen (1981) established that the arid xerophytes communities could be developing since the Middle Eocene, though herbs, grasses and shrub were not abundant. Leopold and Denton (1987), concluded that grass dominated vegetation was common until the middle to late Pliocene and Leopold et al., (1992), in a world-wide
review of pollen records found that even during the Oligocene, the grass pollen is rare and concluded that grass dominated vegetation was common until the middle to late Miocene, when the frequencies of grasses are important in the pollen assemblages.

**Marine palynomorphs**

Preliminary results from the “La Bocana LBA” well indicate the dominance of dinoflagellate cysts, including a morphological complex of *Spiniferites* spp., *Operculodinium centrocarpum*, *Tuberculodinium vancampoae* and *Lingulodinium* sp., among others, suggesting the analyzed part of San Gregorio Formation was deposited in an estuarine environment condition or in marine marginal waters. Furthermore, some taxa for instance *Tuberculodinium vancampoae*, *Chiropteridium lobospinosum* and *Lentinia serrata* have chronostratigraphic value.