SEVILLA Exhibit 1



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4/19/2010

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Calvert County Topographical Map (MD Geological Survey rev 1980), with ADDITION OF LINES MARKING TOPOGRAPHICALLY HIGH LAND AND STRAIGHT STREAM SEGMENTS interpretation by Dr. Susan Kidwell in collaboration with Dr. Peter Vogt:

**Using an existing topographic map of Calvert County, MD:**

1. Many streams have suspiciously long straight stretches and make approximately right-angled turns, which is typical of terrains where there is an underlying structural (tectonic) control on drainage.
2. This contrasts with the "dendritic" (root-like) pattern that typifies terrains lacking any structural control on the weakness of the underlying rocks.
3. Tenured and experienced geologists Dr. Susan Kidwell, Dr. Peter Vogt, and Dr. Curt Larsen concur that in this part of Calvert County there is
   a. a set of stream segments with a basically East-West orientation (indicated by bold solid lines on map; for example, Johns Creek, which heads east toward the southern end of CCNPP property),
   b. a second set of stream segments having a South-Southwest orientation (doubled-lines; for example, St Leonard Creek and its overland extension to Long Beach), and
   c. a third set of mostly minor streams having a South-Southeast orientation (many fine solid lines).
4. The "overlaid stream line segments" on the topographical map have been positioned slightly east or north of the relevant stream so as not to obscure the trace of the stream on the map or the labels providing the stream names.
5. The bold dashed line on the map, running Northeast - Southwest, marks a band of topographically high land that extends from the Calvert Cliffs over to the Patuxent River:
   a. It begins under the Moran property and
   b. coincides with Sollers Road for a considerable stretch and in the direction of the mouth of Mears Cove on the Patuxent River.
   c. This dashed line does not mark the trace of the postulated Moran Fault, but rather the topographic high running land along the edge of the "up-thrown" block. The fault line would be located on the north side of this dashed line within the order of a quarter mile.
6. The location of the CCNPP Unit 3 Cooling Tower, when measured relative to the dashed line is about a half mile northwest of the dashed line; even lying closer to the postulated Moran Landing Fault (less than a half mile).
7. (**Sevilla Exhibit 7**) Dr. Robert Gernant, in the 1970 publication of the Maryland Geological survey, "Report of Investigations No, 12", page 5, Figure 4, published his picture of Calvert Cliffs at "Camp Conoy, YMCA" because he noticed the unusual tilt of the beds in that area of Calvert Cliffs. Dr Gernant's picture is the north cliff view of the same area labeled by Dr. Kidwell in her 1997 JSR study, page 324, Figure 2, as "Conoy Landing"(**Sevilla Exhibits 5 and 6**).
8. Dr. Gernant's publication in 1970 led Dr. Kidwell to examine very carefully Calvert Cliffs especially at the Conoy Landing area, because of the unusual tilt of the beds downwards towards the north. This tilt contrasts the usual tilt of beds downwards towards the south. The significance of this unusual northward tilt is that the beds have been arched slightly by deformation. Such "folding" of the beds is commonly associated with faults.
9. There are thus 3 kinds of evidence suggesting a plausible fault: a) contrast in elevation of beds between north and south sides of "Moran Landing" (underscored in Dr. Vogt's mark-up of Dr. Kidwell's 1997 Fig. 2; b) arching of beds at Conoy Cliff, as diagramed in Kidwell's Figure 2 and as evident in part of Dr. Gernant's Figure 4 in 1970; and c) unpublished 2010 observation by Drs. Kidwell and Vogt of the topographic features as suggested by the line of topographically high land and orientation of the streams as corroborated in part by Dr. Larsen (page 1 this Sevilla Exhibit 4).

PSC 9218 4/19/10 SEVILLA EXHIBIT 5

# ANATOMY OF EXTREMELY THIN MARINE SEQUENCES LANDWARD OF A PASSIVE-MARGIN HINGE ZONE: NEOGENE CALVERT CLIFFS SUCCESSION, MARYLAND, U.S.A.

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**Abstract: Detailed examination of Neogene strata in cliffs 25–35 m high along the western shore of Chesapeake Bay, Maryland, reveals the complexity of the surviving record of siliciclastic sequences ~ 150 km inland of the structural hinge zone of the Atlantic passive margin. Previous study of the lower to middle Miocene Calvert (Plum Point Member) and Choptank Formations documented a series of third-order sequences 7–10 m thick in which lowstand deposits are entirely lacking, transgressive tracts comprise a mosaic of condensed bioclastic facies, and regressive (highstand) tracts are present but partially truncated by the next sequence boundary; smaller-scale (fourth-order) cyclic units could not be resolved. Together, these sequences constitute the transgressive and early highstand tracts of a larger (second-order Miocene) composite sequence. The present paper documents stratigraphic relations higher in the Calvert Cliffs succession, including the upper Miocene St. Marys Formation, which represents late highstand marine deposits of the Miocene second-order sequence, and younger Neogene fluvial and tidal-inlet deposits representing incised-valley deposits of the succeeding second-order cycle. The St. Marys Formation consists of a series of tabular units 2–5 m thick, each with an exclusively transgressive array of facies and bounded by stranding surfaces of abrupt shallowing. These units, which are opposite to the flooding-surface-bounded regressive facies arrays of model parasequences, are best characterized as shaved sequences in which only the transgressive tract survives, and are stacked into larger transgressive, highstand, and forced-regression sets.**

**Biostratigraphic analyses by others indicate that this onshore record contains the same number of third-order (~ 1 my duration) units as present offshore, and so thinning landward of the hinge zone was accomplished not by omission or erosion of entire cycles of deposition, but instead by omission of some subsidiary elements (e.g., lowstand tracts), by erosional shaving of sequence tops (removing the entire regressive tract in some sequences), by a reduced number of component high-order cycles surviving per larger set, and by qualitative changes in the anatomy or composition of elements (e.g., condensed transgressive tracts; shaved sequences rather than parasequences). All of these differences can be attributed to limited accommodation, but preservation of an onshore record of each baselevel cycle was probably also favored by the large amplitude and rapidity of eustatic fluctuations during the Miocene.**

## INTRODUCTION

The anatomy of marine siliciclastic depositional sequences—their three-dimensional form, disconformable boundaries, facies tracts, and stratal stacking patterns—has been documented for a variety of settings of moderate tectonic subsidence (i.e., foreland basins and passive margins seaward of tectonic hinge zones, with rock accumulation rates on the order of hundreds of meters per million years). These relatively expanded records and, to a lesser extent, studies of Holocene environments have shaped geologists' image of depositional sequences over the past 20 years, and have both influenced the search for reservoirs and served as the groundtruth for models exploring the generative effects of tectonism, eustasy, and sediment supply.

Much less information is available on the expression of such sequences landward of hinge zones, in settings of very low to zero tectonic subsidence. Such settings might present many obstacles to sequence analysis. These difficulties include the modest original thickness of sequences due to low accommodation, requiring high-resolution seismic reflection data or exceptional outcrops for study; the high potential for severe or complete erosion of these landward edges of sequences during subsequent lowstands; and the presumed or actual sparsity of marine fossils in such areas, limiting biostratigraphic resolution both along tectonic strike and downdip with expanded sections in the marine depocenter. Disconformity-based subdivision and correlation is also expected to be difficult because of the complex mosaic of erosional and nondepositional surfaces that can form in the coastal environments that typify basin margins, and the potential for these surfaces to crosscut and coalesce.

Many questions thus remain on the actual anatomy of very thin records in such settings, and the controls on their formation. What is the relative importance of erosion (complete removal of selected sequences in the succession), omission (nondeposition of selected sequences), and depositional attenuation (offshore sequences represented but very thin)? What is the physical expression of thin sequences where present: are these simply shrunken versions of offshore sequences, with each component systems tract present but accounted for by sets with fewer or individually thinner subsidiary parasequences? Or does sequence composition change qualitatively across the hinge zone, for example because of: (a) erosional shaving (i.e., partial truncation of the sequence, removing part or all of the highstand systems tract and possibly part of the transgressive systems tract), (b) omission (nondeposition) of one or more component systems tracts (e.g., extreme marine overstep such that the transgressive record consists only of a single flooding surface; bypassing rather than deposition of sediment during the "highstand" phase, leaving only an omission surface; baselevel drop sufficient to disallow deposition of lowstand deposits cratonward of the hinge zone); and/or (c) switchover from "normal" facies types to lithologically unusual facies indicative of low siliciclastic input and/or low net stratigraphic accumulation (e.g., condensed facies rich in biogenic and authigenic grains and fabrics; loss of discrete bedding planes or parasequence-type cyclicity due to amalgamation). Many different combinations of these alternatives are hypothetically possible.

Miocene strata exposed in Calvert Cliffs along the western shore of the Chesapeake Bay in Calvert County, Maryland provide an excellent vehicle to determine the anatomy of marine siliciclastic sequences landward of a passive-margin hinge zone (Fig. 1). The Cliffs contain a biostratigraphically complete record of ~ 10 million years of Miocene time in only ~ 70 m of record, approximately one-tenth the cumulative thickness of coeval strata in the offshore Baltimore Canyon Trough (Greenlee et al. 1992; de Verteuil and Norris 1992; Poag and Ward 1993). Moreover, the high quality of exposure in the Calvert Cliffs is unique in the Atlantic and Gulf Coastal Plains. A relatively continuous series of cliffs 25–35 m high are present along 40 km of shoreline in Calvert County; the largely unlithified strata dip very gently, providing good opportunities to document lateral facies changes (Figs. 1, 2). As the best-exposed onshore record of Neogene sequences in the Atlantic continental margin, the Calvert Cliffs have provided key reference outcrops for biostratigraphic zonations of shallow-water Miocene strata. They are additionally important to tests of eustatic models of sequence generation under "icehouse" conditions and the role of flexural deformation on such mature margins (Greenlee et al. 1992; Schroeder and Greenlee 1993; Sugarman et al. 1993; Poag and Ward 1987; Miller and Sugarman 1995; Pazzaglia and Gardner 1994).

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MARYLAND GEOLOGICAL SURVEY

Kenneth N. Weaver, Director

REPORT OF INVESTIGATIONS NO. 12



# PALEOECOLOGY OF THE CHOPTANK FORMATION (MIOCENE) OF MARYLAND AND VIRGINIA

by

Robert E. Gernant

1970

SEVILLA EXHIBIT 7 (page 2 of 2) PSC 9218 4/19/2010

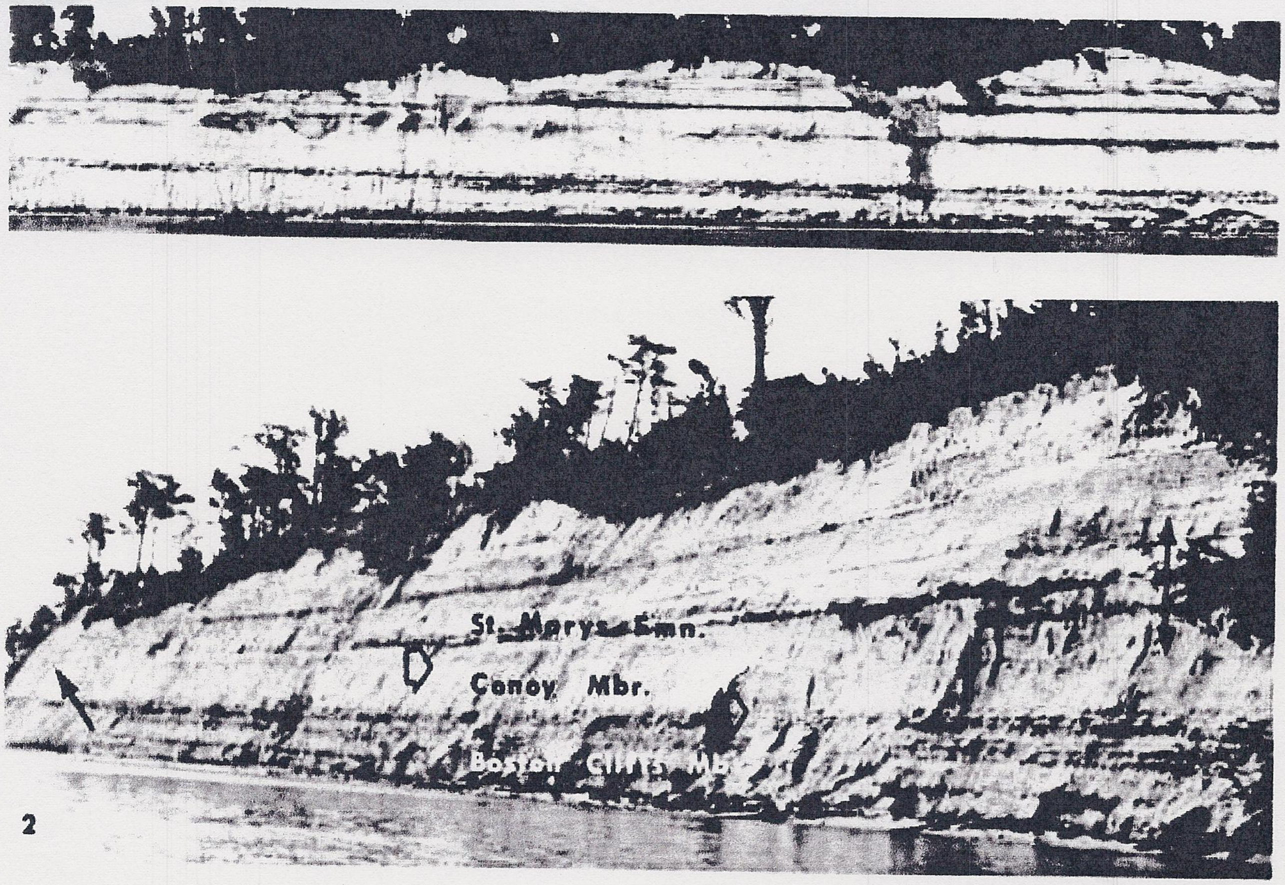


Figure 4: (Different perspectives of same cliff section.) Calvert Cliffs at Camp Conoy Y. M. C. A. Good view of unconformable relationships around Choptank-St. Marys boundary. Type area for Conoy Member. Double-headed arrow on right of lower photo shows thickness of St. Marys at north end of Conoy Cliff not present at south end of Conoy Cliff. Single-headed arrow at left marks Choptank-St. Marys unconformity.

Close examination of the formational contact at locality 67-71 (fig. 5) reveals this to be a surface of erosion. The upper Choptank member is abnormally thin, being only a little over 4 feet thick. Within 500 feet southeast this unit is 8 to 9 feet thick, as can be seen in figure 6. Figure 5 shows the broadly but deeply undulating formation boundary. It also shows the "basal sand" of the St. Marys filling lows in this undulating surface.

## STRATIGRAPHIC NOMENCLATURE

Within the Chesapeake Group of Maryland, Shattuck (1904, pp. *lxix-lxxxvi*) recognized and delineated 24 sub-divisions or "zones". The Choptank consists of "zones 16" through "zone 20". Each "zone" was defined on the basis of lithologic characteristics and the relative quantity of fossil shells, not by the occurrence of particular species. As such, each "zone" is a rock stratigraphic unit (Krumbein & Sloss, 1963, p. 625).

The five subdivisions of the Choptank as recognized by Shattuck are redefined, named, and given type sections in the discussion below.

## SUBDIVISIONS OF THE CHOPTANK FORMATION

*Calvert Beach Member.*—This member corresponds to "zone 16" of Shattuck and lies at the base of the Choptank (fig. 6). The type section, here designated, is the low bluff in the Calvert Cliffs at Calvert Beach, Maryland ((fig. 7,8); also see locality 67-65 in Appendix I for detailed description of the type section). The sediments vary from dusky green to dusky blue, rarely yellowish-brown to dark brown, very muddy to slightly muddy, fine sand to very fine sand. The nature of the lower contact is not clear (see previous discussion) but can be described as subtle (fig. 2,3). The location of the upper contact is difficult to fix because of its gradational character. Inasmuch as the overlying bed is defined in part as a major shell bed, the contact has been placed at the base of the first major influx of shells (fig. 2). Sedimentary structures included in this member are small scour and fill structures (fig. 3), burrows (fig. 7,8), sand stringers and lenses (fig. 2), localized low-angle planar cross laminations, and irregular bedding laminations. In general, macro-