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THE HOT SPRINGS TRAIL REFERENCE SECTION (CENOMANIAN-TURONIAN-CONIACIAN), ERNST MEMBER, BOQUILLAS FORMATION, BIG BEND NATIONAL PARK, TEXAS

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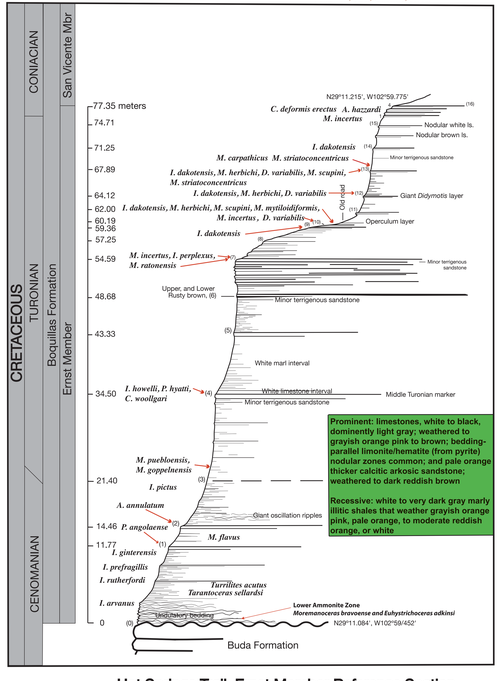
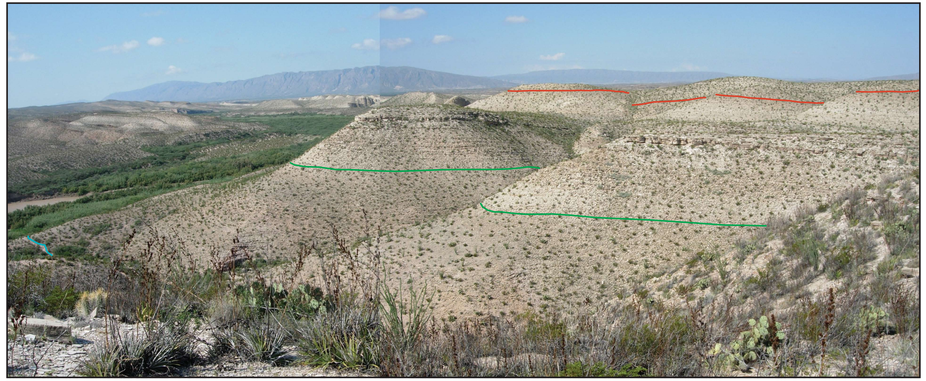
The Hot Springs Trail (HST) measured section is to be established as the formal stratigraphic reference for the Ernst Mbr, Boquillas Fm, Big Bend National Park, TX. The name 'Ernst' derives from an atypical section near Ernst Tinaja, which is not the type locality or area. Basal HST rocks lie disconformably on the Buda Fm with the top defined as the top of the *Allocrioceras hazzardi* Zone, conforming to the Ernst Mbr as redefined by Cooper and others (2004). Detailed mapping, stratigraphy, and paleontology of the rocks over a strike-distance of 80 km indicate that the HST is the most representative in terms of biostratigraphy, lithostratigraphy and thickness. Accessible and protected by the National Park Service, the HST is gently tilted and unfaulted. Differences in lithologic appearance arise from variations in proportions of micrite, microfossil tests, shell material, and terrigenous clays and sand, and sedimentary structures. Coarse-fine mm-scale couplets are near-ubiquitous in the lower half of the section and in the top 10 m, though some resistant ledges are cored with massive micrite or foraminiferal limestone. Ledges in the intervening section are thin-bedded, and terrigenous sand is rarer. Coarse material may be shell fragments or terrigenous sand. Recessive layers are dominated by clay or have many clay partings separating sub-mm–mm limestone laminae, or carbonate laminae sets. Decimeter to cm scale cross-lamination is common at tops of resistant beds. Limonitic zones follow or approximate bedding, and result from oxidation/hydration of sulfide accumulations. Identified fossils (1995-present: W.A. Cobban, USGS) correlate the HST with established Western Interior Seaway, northern European, Tethyan and Pacific Rim inoceramid interval and ammonite taxon range zones. The HST spans the Cenomanian-Turonian and Turonian-Coniacian Stage Boundaries, and extends the North American geographic range of some species up to 1100 km further south than previously known.

Lower Ammonite zone that contains *Moremanoceras bravoense* and *Euhystrichoceras adkinsi* of the *Acompsocera inconstans* Zone of Late Lower Cenomaninan age (photo by R.S. Cooper).

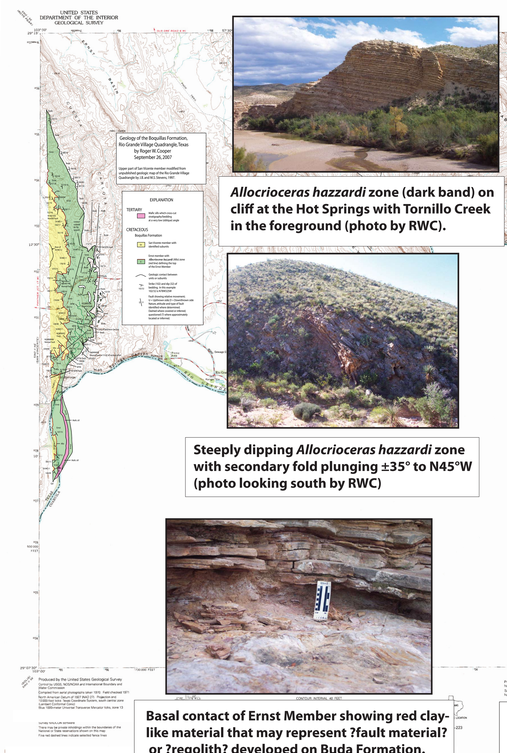
Undulatory bedding due to scouring currents typical of the lowermost Ernst Member (photo by RWC). Limestone layers often/usually have internal cross-bedding.



Hot Springs Trail, Ernst Member Reference Section



Hot Springs Trail Reference Section of the Ernst Member of the Boquillas Formation showing the Buda-Ernst contact (blue line), the Middle Turonian limestone layer with *I. howelli and P. hyatti* (green line), and the *Allocrioceras hazzardi* zone (red line) marking the top of the Ernst Member.



***Allocrioceras hazzardi* zone (dark band) on cliff at the Hot Springs with Tornillo Creek in the foreground (photo by RWC).**

Large oscillation ripplemarks with 0.5-1m wavelength and internal cross-bedding in the lower Ernst Member (photo by RWC).

Steeply dipping *Allocrioceras hazzardi* zone with secondary fold plunging ±35° to N45°W (photo looking south by RWC)

***Allocrioceras hazzardi* zone showing the four indurated layers and the three carbonate mud/shale intervals that make up the 1.29m (avg. thickness) zone (photo by RWC).**

Basal contact of Ernst Member showing red clay-like material that may represent ?fault material? or ?regolith? developed on Buda Formation.

Conformable contact of the Buda Formation and the base of the Ernst Member of the Boquillas Formation (photo by RWC).

Unpublished Regional Chart compiled by W.A. Cobban
(graphics by K.C. McKinney, modified by Cooper et. al.)

STAGES AND SUBSTAGES		STAGE BOUNDARIES (Gradstein et al 2004)	AMMONITE TAXON RANGE ZONES	AGE (Obradovich 2006) MA	WESTERN INTERIOR INOCERAMID INTERVAL RANGE ZONES	PROVISIONAL AMMONITE ZONATION SOUTHWEST NEW MEXICO AND TRANS-PECOS TEXAS
CAMPANIAN (PART)	Upper (part)		*Baculites aspiniformis* *Baculites maclearni* *Baculites obtusus*	80.58 ± 0.55	*Cataceramus subcompressus* *Cordiceramus eberhardi/danicus*	*Hoplitoplacenticeras* spp.
	Lower	83.5 ± 0.7	*Baculites* sp. (weak flank ribs) *Baculites* sp. (smooth) *Scaphites hippocrepis III* *Scaphites hippocrepis II* *Scaphites hippocrepis I* *Scaphites leei III*	81.86 ± 0.36	*Cataceramus* ex gr. *C. balticus*	*Menabites (Delawarella) sabinaensis* *Menabites (Delawarella) delawarensis*
					San Vicente Member	
SANTONIAN	Upper		*Desmoscaphites bassleri* *Desmoscaphites erdmanni* *Clioscaphites choteauensis*	84.3 ± 0.54	*Sphenoceramus lundbreckensis*	*Placenticeras shilohense*
	Middle				*Cordiceramus buetherensis*	*Texanites texanus gallicus*
	Lower	85.8 ± 0.7	*Clioscaphites vermiformis* *Clioscaphites santonianus*			*Texanites texanus texanus*
CONIACIAN	Upper		*Scaphites depressus*	87.14 ± 0.39	*Clisbococeramus undulatoplicatus* *Magadiceramus crenelatus* *Magadiceramus subquadratus*	*Placenticeras stangeri deniseoceratus* *Protexanites* spp. ***Protexanites bourgeotianus***
	Middle		*Scaphites ventricosus*	88.55 ± 0.59	*Volviceramus involutus* *Volviceramus koeneni*	*Peroniceras westphalicum*
	Lower	89.3 ± 1.0	*Scaphites preventricosus*		*Cremnoceramus crassus crassus* *Cremnoceramus crassus inconstans* *Cremnoceramus deformis erectus* *Cremnoceramus waltersdorfensis waltersdorfensis*	*Forresteria alluaudi* *Municericeras hazzardi*
TURONIAN	Upper		*Scaphites marsasensis* *Pionocyclus germari* *Scaphites nigricollensis* *Scaphites whitfieldi*		*Cremnoceramus waltersdorfensis* *Mytiloides acuatus* *Mytiloides incertus* *Inoceramus dakotensis* *Inoceramus perplexus*	*Forresteria peruana* *Pionocyclus germari* *Pionocyclus quadratus* *Scaphites whitfieldi*
	Middle		*Scaphites ferronensis* *Scaphites warreni* *Pionocyclus macombi* *Pionocyclus hyatti* *Coilignoceras praecox* *Coilignoceras woollgari*	90.21 ± 0.72 92.46 ± 0.58	*Inoceramus dimidus* *Inoceramus* aff. *dimidus* *Inoceramus howelli* *Inoceramus* n. sp. *Mytiloides hyrcnicus* *Mytiloides subhystricoides*	*Scaphites ferronensis* *Scaphites warreni* *Pionocyclus macombi* *Pionocyclus hyatti* ? *Coilignoceras woollgari regulare* *Coilignoceras woollgari woollgari*
	Lower	93.5 ± 0.3	*Mammites nodosoides* *Vascoceras birchbyi* *Pseudaspidoceras flexuosum* *Watinoceras devonense*	93.48 ± 0.58 93.19 ± 0.42	*Mytiloides mytiloides* *Mytiloides kossmati* *Mytiloides puebloensis*	*Mammites nodosoides* *Vascoceras birchbyi* *Pseudaspidoceras flexuosum* ?
CENOMANIAN	Upper		*Neokentrolites ecotii* *Neocardioceras juddi* *Burroceras clydense* *Euomphaloceras septemseriatum* *Vascoceras diartianum* *Dunveganoceras conditum* *Dunveganoceras albertense* *Dunveganoceras pondereum* *Dunveganoceras pondi*	93.32 ± 0.38 93.82 ± 0.30 93.68 ± 0.50 93.99 ± 0.72 94.71 ± 0.49	*Mytiloides hattin* *Inoceramus pictus* *Inoceramus ginterensis*	*Neocardioceras juddi* *Burroceras clydense* *Euomphaloceras septemseriatum* *Vascoceras diartianum* ? *Metoicoceras* spp. ? *Calycoceras* (*Pseudocalycoceras*) *conale conlinaense*
	Middle		*Plesiacanthoceras wyomingense* *Acanthoceras amphibolum* *Acanthoceras bellense* *Acanthoceras muldoonense* *Acanthoceras granerosense* *Conlinoceras tarrantense*	94.96 ± 0.50	*Inoceramus prefragilis* *Inoceramus rutherfordi* *Inoceramus arvanus* *Inoceramus naccovnetti*	? *Acanthoceras amphibolum* *Acanthoceras bellense*
					Ernst Member	
	Lower	99.6 ± 0.9	*Neogastroplites* spp	95.73 ± 0.51	*Inoceramids present*	*Forbesiceras brundrettei* *Acompsoceras* ? *Neophycloceras* (*Budiceras*) *hyatti* *Neophycloceras* (*Neophycloceras*) *texanum* *Graysonites wacoensis* *Graysonites adkinsi*