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"Caribbean Exploration – Planning for the Future"

ABSTRACT

TRINIDAD – VENEZUELA 11-0 Ma SUPRAOROGEN BASINS FORMED BY BURIED – HALITE DISSOLUTION

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There is diverse evidence for a thick (km), largely dissolved, lowest Cretaceous halite unit, here named the Carib Halite Formation, deposited in a graben complex reaching from Colombia to Trinidad, resulting from rifting in W Pangea. The graben preceded sea-floor spreading, which formed the Proto-Caribbean seaway and the N-facing Trinidad-Venezuela passive margin, with its exceptional Upper Cretaceous petroleum source rocks.

The halite is known in Colombia, where diapirs crop out near Bogota, and in Guatemala-Yucatan, which was contiguous with Venezuela prior to spreading. In Trinidad and Venezuela, evidence consistent with buried halite, unreached by drilling, includes: (1) saline springs; (2) high geothermal gradient ("hot wells"); (3) gravity anomalies; (4) thrust-belt structural style; and (5) possible halite diapirs on seismic profiles (Venezuela).

There is also much evidence for *vanished* (dissolved) halite, including: (1) a Berriasian-Valanginian 'faunal gap' throughout Trinidad and Venezuela (Figs 1, 2), coeval with the Bogota halite, coincident with a profound eustatic low (Haq chart), inferred to have isolated the 'Carib Graben' from the world ocean, enabling halite deposition; (2) 'drowning coast' geomorphology (deeply indented bays; alluviating valleys; N Range and E Venezuela), indicating subsidence despite the current transpressive setting (see companion abstract); (3) reflecting the halite-dissolution weld, discontinuities in grade of lithification (e.g. Rio Negro-La Quinta Fms) or grade of metamorphism (Laventille on Chancellor; Toco on Sans Souci; Cuche on Couva; all in the Northern Range 'Shelf Nappe'; companion abstract); (4) reverse fracture-density gradients (e.g. Laventille more fractured than Chancellor), reflecting dissolution collapse; (5) Morichito Basin clinoforms, interpreted as rollover due to halite lateral retreat; (6) gypsum veins, common at outcrop in Trinidad and Venezuela, typical of roof strata above dissolved halite; (7) oils with evaporitic signatures; (8) anomalous oilfield brine salinity; (9) highly saline fluid inclusions in Neogene veins in Shelf Nappe metamorphics (C Venezuela); (10) mineral shows compatible with halite influence (N Range, Araya-Paria, Merida Andes); and (11) supraorogen Neogene basins with block-faulted structural style, anomalous in the compressive-then-transpressive Neogene plate-tectonic context (companion abstract).

Supraorogen-basin subsidence is attributed here to buried-halite dissolution caused by a change, associated with the 11-0 Ma glacioeustatic low, to a wetter climate in Venezuela-Trinidad, especially during each post-glacial 'pluvial' episode. Rainwater

penetrated deep underground, aided by high relief and intense fracturing of the Proto-Caribbean orogen (companion abstract). Some basin areas are still subsiding (e.g. Gulfs of Barcelona and Paria; Carupano-N Coast Basin). In contrast, the dissolution-basin fill in Trinidad (Manzanilla-Cruse through Talparo-Erin fms) was folded and thrusted due to halite exhaustion, in Quaternary time (post-Talparo-Erin), before the 1.5 Ma plate-boundary jump (companion abstract). Structural disharmony at the base of this package reflects previous Proto-Caribbean thrust advance.

The fill of the dissolution basins is characterized on seismic profiles by listric growth faults ('pseudo-extensional basins'), but published laboratory models show that such faults also characterize halite-dissolution basins. The models also produced flower-like structures above the sides of the modeled halite body, simulating graben-floor steps or diapir walls, and explaining flower-like structures in the Gulf of Paria. The maximum age span of the syn-dissolution (growth-faulted) interval in any basin is Late Miocene to Recent. Based on the average thickness of this interval in the Gulf of Paria (Manzanilla through Cedros fms), the pre-dissolution average thickness of the Carib Halite was about 4 km, consistent with the metamorphic discontinuity. The southern depositional limit of the halite was probably the Trinidad South Coast-Maturin Thrust (reactivated former graben border?), as this confronts a major backthrust, suggesting pinchout of an efficient detachment horizon.

The Carib Halite concept, and the corollary that rifting lasted much later than previously inferred (companion abstract), will profoundly affect exploration strategy in Trinidad and Venezuela, changing interpretations of subsidence history, heat-flow/maturation history (high halite conductivity; longer rifting), paleogeography, structure/traps (halite decollement; dissolution collapse), evaporitic source rocks, seals, etc.. The popular pullapart model for the Gulf of Paria, implying gross palinspastic-paleogeographic distortion of Trinidad, is a fallacy.

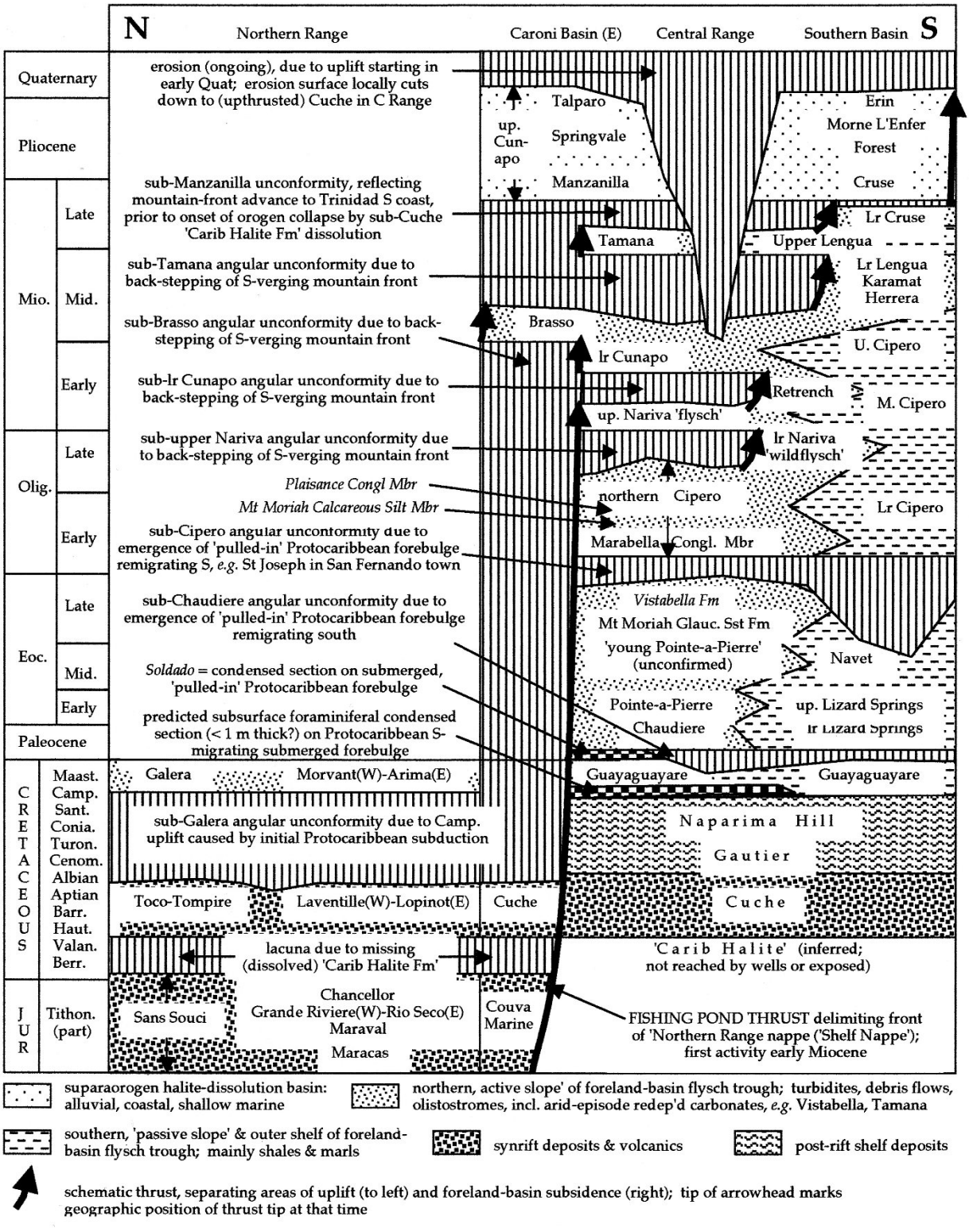
N
Northern Range
Caroni Basin (E)
Central Range
Southern Basin
S
Quaternary
Pliocene
Mio.
Late
Mid.
Early
Olig.
Late
Early
Eoc.
Late
Mid.
Early
Paleocene
CRETACEOUS
Maast.
Camp.
Sant.
Conia.
Turon.
Cenom.
Albian
Aptian
Barr.
Haut.
Valan.
Berr.
JUR
Tithon. (part)
erosion (ongoing), due to uplift starting in early Quat; erosion surface locally cuts down to (upthrusted) Cuche in C Range
sub-Manzanilla unconformity, reflecting mountain-front advance to Trinidad S coast, prior to onset of orogen collapse by sub-Cuche 'Carib Halite Fm' dissolution
sub-Tamana angular unconformity due to back-stepping of S-verging mountain front
sub-Brasso angular unconformity due to back-stepping of S-verging mountain front
sub-lr Cunapo angular unconformity due to back-stepping of S-verging mountain front
sub-upper Nariva angular unconformity due to back-stepping of S-verging mountain front
Plaisance Congl Mbr
Mt Moriah Calcareous Silt Mbr
sub-Cipero angular unconformity due to emergence of 'pulled-in' Protocaribbean forebulge remigrating S, e.g. St Joseph in San Fernando town
sub-Chaudiere angular unconformity due to emergence of 'pulled-in' Protocaribbean forebulge remigrating south
Soldado = condensed section on submerged, 'pulled-in' Protocaribbean forebulge
predicted subsurface foraminiferal condensed section (< 1 m thick?) on Protocaribbean S-migrating submerged forebulge
sub-Galera angular unconformity due to Camp. uplift caused by initial Protocaribbean subduction
lacuna due to missing (dissolved) 'Carib Halite Fm'
Talparo
up. Cun-apo
Springvale
Manzanilla
Erin
Morne L'Enfer
Forest
Cruse
Tamana
Lr Cruse
Upper Lengua
Lr Lengua
Karamat
Herrera
Brasso
U. Cipero
lr Cunapo
Retrench
M. Cipero
up. Nariva 'flysch'
lr Nariva wildflysch'
northern Cipero
Lr Cipero
Marabella Congl. Mbr
Vistabella Fm
Mt Moriah Glauc. Sst Fm
'young Pointe-a-Pierre' (unconfirmed)
Navet
Pointe-a-Pierre
up. Lizard Springs
Chaudiere
lr Lizard Springs
Galera
Morvant(W)-Arima(E)
Guayaguayare
Guayaguayare
Naparima Hill
Gautier
Toco-Tompire
Laventille(W)-Lopinot(E)
Cuche
Cuche
'Carib Halite' (inferred; not reached by wells or exposed)
Chancellor
Grande Riviere(W)-Rio Seco(E)
Maraval
Sans Souci
Maracas
Couva Marine
FISHING POND THRUST delimiting front of 'Northern Range nappe ('Shelf Nappe'); first activity early Miocene
suparaorogen halite-dissolution basin: alluvial, coastal, shallow marine
northern, active slope' of foreland-basin flysch trough; turbidites, debris flows, olistostromes, incl. arid-episode redep'd carbonates, e.g. Vistabella, Tamana
southern, 'passive slope' & outer shelf of foreland-basin flysch trough; mainly shales & marls
synrift deposits & volcanics
post-rift shelf deposits
schematic thrust, separating areas of uplift (to left) and foreland-basin subsidence (right); tip of arrowhead marks geographic position of thrust tip at that time

Figure 1

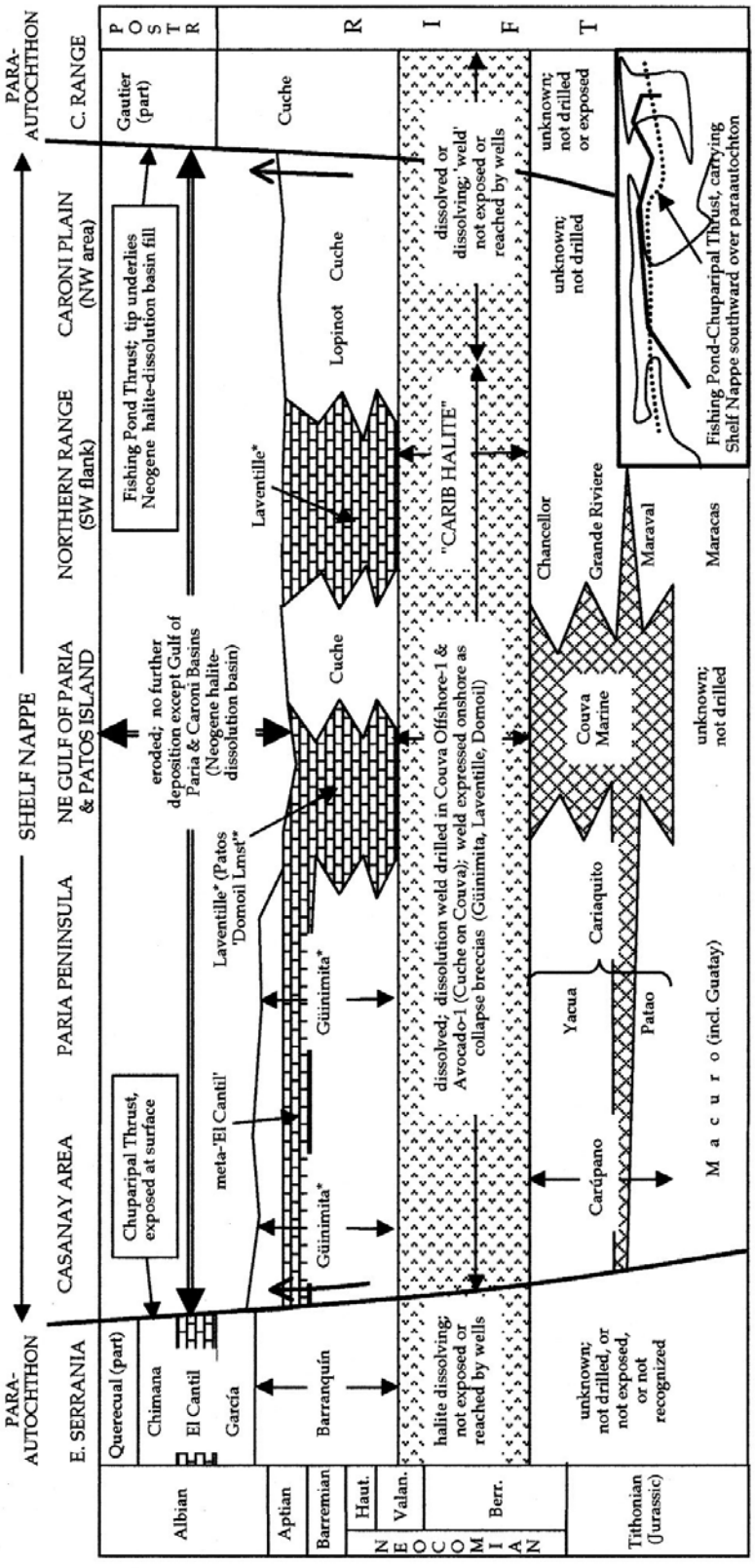
PARA-AUTOCHTHON
SHELF NAPPE
PARA-AUTOCHTHON
E. SERRANIA
CASANAY AREA
PARIA PENINSULA
NE GULF OF PARIA & PATOS ISLAND
NORTHERN RANGE (SW flank)
CARONI PLAIN (NW area)
C. RANGE
POSTRIFT
Albian
Aptian
Barremian
Haut.
Valan.
Berr.
NEOCOMIAN
Tithonian (Jurassic)
Querecual (part)
Chimana
El Cantil
García
Barranquín
halite dissolving; not exposed or reached by wells
unknown; not drilled, or not exposed, or not recognized
Chuparipal Thrust, exposed at surface
meta-'El Cantil'
Güinimita*
Güinimita*
Laventille* (Patos 'Domoil Lmst'*
eroded; no further deposition except Gulf of Paria & Caroni Basins (Neogene halite-dissolution basin)
Cuche
dissolved; dissolution weld drilled in Couva Offshore-1 & Avocado-1 (Cuche on Couva); weld expressed onshore as collapse breccias (Güinimita, Laventille, Domoil)
Yacua
Cariaquito
Patao
Carúpano
M a c u r o (incl. Guatay)
Fishing Pond Thrust; tip underlies Neogene halite-dissolution basin fill
Laventille*
Lopinot
Cuche
"CARIB HALITE"
Chancellor
Couva Marine
unknown; not drilled
Grande Rivière
Maraval
unknown; not drilled
Maracas
Gautier (part)
Cuche
dissolved or dissolving; 'weld' not exposed or reached by wells
unknown; not drilled or exposed
Fishing Pond-Chuparipal Thrust, carrying Shelf Nappe southward over paraautochton
RIFT

Figure 2

Figure 1. Trinidad stratigraphic chart. Vertical axis is time, not to scale. Formations or members in italics are presumed deposited farther north; they are shown in their correct stratigraphic positions, but are known only as olistoliths in younger formations. San Fernando Fm is abandoned here: its various members are reassigned stratigraphically upward as shown (Plaisance Conglomerate; Mount Moriah Calcareous Silt) or elevated to formation status (Mount Moriah Glauconitic Sandstone Fm; Vistabella Fm, comprising Vistabella Marl and Vistabella Limestone Members). Note that the frontal thrust (black arrow) jumped forward overall through time, but occasionally stepped backward. Prior to Miocene time, the active thrust was at the front of the Slope Nappe, which has been entirely eroded off the top of the Shelf Nappe (cf. companion abstract, Fig. 1). Neglects Pleistocene terrace deposits (Cedros Fm).

Figure 2. Interpreted uppermost Jurassic-Lower Cretaceous stratigraphy of northern fringe of Trinidad and E Venezuela, showing inferred stratigraphic position of the Carib Halite. Gulf of Paria data are from Domoil-1, Avocado-1, Couva Marine-2 and Couva Offshore-1 well files. Asterisk denotes strong fracturing/brecciation reported in the literature, attributed here to halite-dissolution subsidence. Shelf Nappe succession shows downward increasing metamorphism, due to former burial under Slope Nappe, hence overmature Cuche and recrystallisation of Güinimita, Laventille and Domoil limestones (impedes dating; Higgs, in review).