

Conjugate Basins, Tectonics and Hydrocarbons (CBTH) – Phase VI (2020-2023)

Submitted
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Project background

The CBTH Project, or “Conjugate Basins, Tectonics and Hydrocarbons Project” began with the financial support of a consortium of oil companies on September 1, 2005 and has operated continuously for the past 15 years within five three-year phases identified as I (2005-8), II (2008-11), III (2011-14), IV (2014-17), and V (2017-2020). This proposal requests funds to continue the consortium for Phase VI that would begin on September 1, 2020, and extend for a three-year period to August 31, 2023. For Phases I-IV, the previous title of the consortium was “Caribbean Basins, Tectonics and Hydrocarbons (CBTH) Project,” which was changed to the new title of “Conjugate Basins, Tectonics and Hydrocarbons (CBTH) Project” for Phase V in 2017.

Main focus areas for Phase VI

Phase VI of our study will focus on improving our plate models and regional paleogeography for the entire CBTH study area and improving our basinal understanding for four geographic regions that encompass most of the top offshore, producing areas of the western hemisphere:

1) **CBTH plate model and accompanying paleogeographic maps.** Our plate model and paleogeographic maps have been continually refined since the start of the project in 2005. Our recent model is available for sponsors in PaleoGIS and has been published in the following papers: 1) Sanchez et al., 2019; 2) Gomez et al., 2018; 3) Escalona et al. (in press, a, b). During Phase VI, we will be able to refine the model for the GOM and the Central and South Atlantic.

2) **the conjugate margins of the US and Mexican Gulf of Mexico (GOM).** Our recent completed studies by Lin et al. (2019), Steier and Mann (2019), Liu et al. (2019) and Kenning and Mann (in press, a, b, c) and have sharpened the focus of continuing Phase VI mapping and basin modeling in the GOM.

3) **the conjugate margins of the South Atlantic with emphasis on the Brazilian margin.** Previous work Reuber and Mann (2019) and Reuber et al. (2019) along with our agreements and data sharing with the Agencia Nacional do Petroleo, Gas Natural, Biocombustiveis (ANP) in Brazil, ION, and PGS are setting the stage for some excellent work by our group in this area with two new Brazilian rifted-passive margin begun in 2020; the Reuber and Mann (2019) paper which addressed rift mechanisms on South Atlantic margins using ION Span data was recently awarded the 2019 best paper award for the journal *Interpretation*.

4) **the conjugate margins of the Central and Equatorial Atlantic margins with emphasis on the conjugate margins of northwestern Africa, northeastern South America and eastern North America.** For this vast, underexplored area, our emphasis is on a complete mapping of northwestern Africa and its correlations with its conjugates in northeastern South America. We have two current projects on northwestern Africa that will produce a semi-continuous map from Gibraltar to the Guinea plateau.

5) **the Caribbean area, which is a non-conjugate area.** This area represents the initial focus of the CBTH Project beginning in 2005. In this area we have completed many projects during Phase V on the Nicaraguan Rise (Carvajal et al., 2015; Carvajal and Mann, 2018; Sanchez et al., 2019; Torrado et al., 2019); in the Trinidad-Barbados area (Alvarez et al., in press, a, b; Gomez et al., 2018, in press; Hippolyte and Mann, in press); in eastern Venezuela and the Orinoco delta (Castillo and Mann, in press; Rodriguez et al.

in press), western Venezuela (Blanco and Mann, in press), and Colombia (Pachon et al., in press; Vence et al., in press; Sanchez and Mann, in press; Mejia et al., in press; and Leslie and Mann, in press).

As our mapping is most mature in the Caribbean, we have refocused our studies towards using the map base for basin modeling and hydrocarbon play development (Leslie and Mann, in press; Mann et al., in press; Tillman and Mann, in press). We have also completed a study which combines all of our previous Caribbean basement and terrane studies into a single, integrative study (Romito and Mann, in press). This basement study is available for download to our sponsors as digital products in our CBTH annual deliverables and on the Geopost data portal.

Our efforts for Phase VI in the Caribbean area focus on new studies of the subduction systems of the western and eastern Caribbean plate: the Sandino forearc basin in Central America and the Barbados accretionary prism, the Tobago forearc basin, and the Grenada backarc basin in the eastern Caribbean. We are also continuing the multi-year study by Alejandro Escalona and PhD student Andres Cedeno on sampling and geochemical typing of oils from the Caribbean area. This final year of the study will complete sampling in Jamaica and in the Guyana basin of Suriname. Three papers summarizing work to their geochemical studies to date are provided by Cedeno et al., (in press, a, b, c).

Product delivery for Phase V

Recently completed CBTH-sponsored, Caribbean and northern South American work is now in press as part of two special publications: 1) A 26-chapter AAPG Memoir on the Caribbean and northeastern South America that is being edited by Dr. Claudio Bartolini (9 of the chapters are based on CBTH work); and 2) an 8-paper special issue of the journal *Interpretation* on the petroleum geology of Colombia (5 of the papers are based on CBTH work). All of these results and their component digital maps are available in our annual data releases.

We will also deliver our three-year digital atlas to sponsors on September 1, 2020. This atlas also focusses on the four focus areas mentioned above and provides regional maps of key surfaces for those entire regions along with maps of other key features such as the continent-ocean boundary, isopachs, and areas of seaward-dipping reflectors.

Many of our upcoming products will be improved iterations of Phase V maps including: 1) updated quantitative plate models and paleogeographic maps; 2) new or improved basin framework studies (GOM, Brazil, NE South America, NW Africa, Central American and Lesser Antilles subduction systems. We will alert sponsors when these are completed and posted to our website. We have also had many successful progress reports via Teams or Zoom with our sponsors during the spring of 2020 and will continue this practice:

- CNOOC Intl. (Houston): February 11, 2020
- PGS (Houston): February 26, 2020
- Hess (Houston): March 6, 2020
- Petrobras (Rio de Janeiro – virtual): March 18, 2020
- Occidental (Houston – virtual): March 19, 2020
- ExxonMobil (The Woodlands): March 20, 2020
- Total (Houston – virtual): April 9, 2020

- ION (Houston – virtual): April 17, 2020
- Shell (Houston – virtual) – Part 1: GOM, Caribbean: April 29, 2020
- Shell (Houston – virtual) – Part 2: Atlantic margins: April 30, 2020
- Equinor (Stavanger – virtual): May 13, 2020
- Total (Pau, France – virtual): May 20, 2020
- Hess (Houston – virtual): May 21, 2020

Special challenges in 2020

We fully understand that 2020 is proving to be a particularly challenging time for the oil industry that is facing the compound issues of social distancing due to the coronavirus and the linked problem of the low oil price. Two important points on these challenges are: 1) because we in the CBTH can all work and communicate remotely, we have been able to maintain a high level of productivity that includes our keeping in close touch with our sponsors and making all of our results available 24/7 through our new Geopost online mapping database; and 2) we are a cost-efficient group that can supply low-cost and time-saving products to our sponsors; these products include quantitative plate models constrained by our extensive data base; original studies of crustal and stratigraphic basin framework of key petroleum provinces; and exploration applications including quantitative basin modeling and play development.

Project management of personnel for CBTH Phase VI at UH and UiS

As with the previous phases of this study (2005-2020), CBTH Phase VI will continue the scientific and educational collaboration between research groups at two separate universities: The University of Houston (Paul Mann, co-PI) and the University of Stavanger, Norway (Alejandro Escalona, co-PI). Mann - a professor at the University of Houston (UH) - will continue to supervise BS, MS and PhD level students and manage GIS and student support staff at UH. UH will act as the main base for the CBTH Phase VI project with a current (May 2020) total of 21 researchers, graduate students, and undergraduate students supported by CBTH. Escalona, a professor the University of Stavanger (UiS), supervises BS, MS, and PhD students along with GIS and student support staff at UiS.

These students will work on various CBTH-funded projects in our expanded study area (boxes in Figure 1 indicate the various student projects discussed in detail below). Mann and GIS specialist and post-doctoral fellow, Dr. Lei Sun, also manage undergraduate workers who contribute towards our GIS database and conduct senior research projects that are part of their BS degrees in either geology or geophysics at UH. A. Escalona, together with Lisa Bingham (Associate Professor and GIS expert) at UiS, will supervise students and research assistants.

Due to the proximity of UH to most of the CBTH sponsors in Houston, Mann and the UH group will host the annual, one-day, CBTH year-end meeting in September of each year of the project (next year-end meeting scheduled for Friday, September 25, 2020). During this meeting, all researchers will summarize progress for the year in a series of talks and future plans will be discussed for the coming year.

Information on all current researchers involved with both the UH and UiS groups are summarized on the CBTH website: http://cbth.uh.edu/proj_res.php

Data sources and products for CBTH Phase V

As with the previous CBTH project phases, CBTH Phase VI data sources include 2D seismic data, well data, outcrop data, previous publications on the region, and original seismic and well data provided with permission by the sponsoring companies or government agencies. As we have done over the past 15 years of the study, CBTH Phase VI will continue to respect the conditions placed on the use of donated data either by the research staff or by graduate and postdoctoral researchers employed by the project.

The CBTH Phase VI study will integrate the results of our own seismic interpretation and well correlations over the entire region to produce structural, isopach, and paleogeographic maps, which we make available to our sponsors in digital format. These data will be integrated with our large GIS database and literature compilation to produce regional and more detailed geologic models and will serve as a basis for modeling and visualization of critical hydrocarbon basins in the area.

Proposed work for CBTH Phase VI (2020-2023) will continue to focus on understanding the regional geology and basin-forming mechanisms of the study area and will also address improved characterization and modeling of the many petroleum systems in the study area (e.g. source, reservoir, trap, seals, etc.). In addition, we will continue to update and expand our database compilation in the key exploration areas that are described in detail below and shown on Figure 1. The level of detail for these local studies will largely depend on the amount of new data we can access for the project. Our practice is not to accept new graduate students into the project until we have verified that they have obtained access and permission for a dataset.

CBTH website upgrade through our partnership with Geopost

Beginning in 2018, CBTH partnered with Geopost Brazil to develop a web-based application custom built on the ArcGIS Online platform that enables the sponsors to visualize CBTH annual release data in a web browser, eliminating the need to load the data on their own ArcGIS system. The interface is user-friendly, regularly updated throughout the year, and all layers can be toggled on and off for viewing.

Over the past two years, CBTH personnel have been working with Geopost to populate our new online data portal with all CBTH deliverables going back to Phase I in 2005. During this ongoing process, we have worked to ensure that all relevant materials are posted in the highest quality possible, often going back to the original thesis and publication files to ensure that figures and maps are posted in the highest resolution available. We have also worked to eliminate redundancy by consolidating outdated materials, merging datasets, and meticulously comparing materials to our ongoing Contributions List. By performing a high level of quality control, workers with CBTH and Geopost are making certain that the new data portal will be the most streamlined version of the CBTH database yet.

Moving forward, the CBTH Geopost data portal will replace the existing Geomapper application as the primary means of data visualization for CBTH materials. Access to Geopost is now included in the annual membership cost for the CBTH Project. For continuing sponsors, credentials are generated and distributed by Geopost following each annual sponsor meeting. All current and previous data releases will still be available through our secure FTP.

Figure 2 shows the CBTH Geopost data portal with selected surfaces and research

study areas. With Geopost, a user can open a geographic window, easily display the many categories of CBTH data from this area, and then download various files including thesis and publication PDFs, raster grids, and vector data including wells, seismic locations, seeps, basement terranes, and much more.

Deliverables for CBTH Phase VI

The focus areas and deliverables for each year of the project will be discussed during each annual meeting with sponsors and will be subject to changes depending on the availability of new data. Deliverables provided to sponsors as part of CBTH Phase VI will include: (1) an integrated and user-friendly GIS database which is updated regularly and accessible via Geopost through our website; (2) iterative updates of plate tectonic and paleogeographic models built in PaleoGIS and GPlates and posted with documented data sources such as wells, radiometric dates, etc.; (3) a series of structural and stratigraphic maps of key seismic surfaces in the region formatted for our 3-year atlas delivery; (4) our original interpretations of seismic data and well data; (5) basin modeling results using the most complete compilations of available data; (6) student and researcher poster and oral presentations from international meetings including the AAPG annual meeting held in the US (mainly presentations by the UH group) and the EAGE meeting in Europe (mainly presentations by the UiS group); and (7) access for sponsors to the online CBTH Phases I-V database on Geopost where all project information can be downloaded in a targeted and more efficient year-by-year manner. In addition to these web-based products, we will continue to provide sponsors with an annual atlas in the third and final year of each phase and FTP delivery of the annual deliverables.

Our year-end meeting held at UH in September of each year of the project will involve oral presentations by members of the UH and UiS groups. We use an 80-person-capacity meeting room at the University of Houston and welcome as many company representatives as you would like to send to the year-end meeting. In addition to the year-end meeting, we organize a luncheon at each annual meeting of AAPG-ACE. This annual luncheon is a good opportunity for sponsors to meet with the CBTH group and learn more about our presentations at the meeting, which is the primary conference to present at for most CBTH researchers at UH. We also frequently conduct office visits during the course of the year with the UH-based group visiting those sponsors in Houston and the UiS-based group visiting those sponsors in Europe.

Cost of CBTH Phase VI

The total cost of the three-year CBTH Project Phase VI is \$216,000 per sponsor. We will require a three-year financial commitment from all CBTH Phase VI sponsors with a minimum annual fee of \$72,000 US due by August 15 of each year starting with year one of the project in September 2020. If sponsor payments are not received by August 31, 2020, we will consider these companies “late buy-ins” who will be charged 150% of the annual \$72,000 US rate (\$108,000).

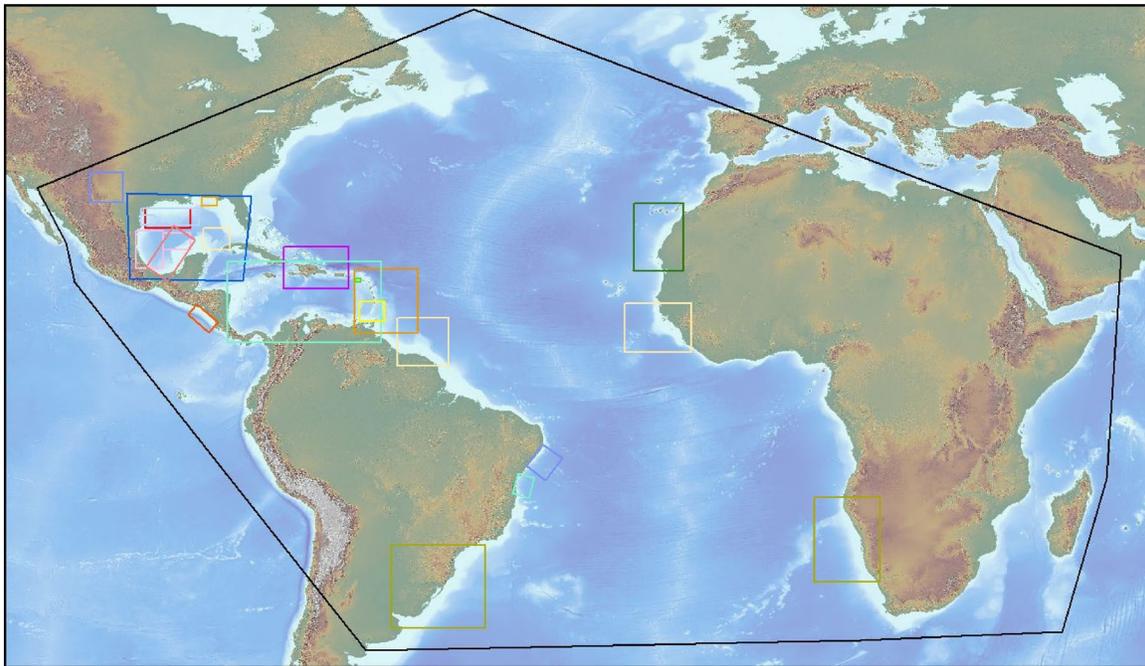
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 Sharon Cornelius, Post-Doctoral Fellow	 Md Nahidul Hasan, PhD
 Lei Sun, Post-Doctoral Fellow	 Matthew Storey, MS
 Jack Kenning, PhD	 Jacob Miller, MS
 Marcus Zinecker, PhD	 Benjamin Miller, MS
 Nawaz Bugti, PhD	 Maddie Bishop, MS
 Mei Liu, PhD	 Bryan Moore, MS
 Sean Romito, PhD	 Sarah Meyer, Post-Bacc.
 Hualing Zhang, PhD	 Tarek Galhom, MS

Figure 1. CBTH Phase VI proposed study area. Colored boxes correspond to Phase V, Year 3 student study areas:

1. Sharon Cornelius, Post-Doctoral Fellow: subsalt GOM
2. Lei Sun, Post-Doctoral Fellow: Hispaniola and Northeastern Caribbean
3. Jack Kenning, PhD, May 2020: structure, basin modeling, western MGOM and Mexican Ridges Fold Belt
4. Marcus Zinecker, PhD: northwest Africa
5. Nawaz Bugti, PhD: Port Isabel fold-thrust belt, northwestern Gulf of Mexico.
6. Mei Liu, PhD: GOM gravity inversion for crustal thickness; mapping of marginal rift system
7. Sean Romito, PhD: West Africa and South America conjugate margins
8. Hualing Zhang, PhD: Permian Basin
9. Md Nahidul Hasan, PhD: Campeche Salt province, GOM
10. Matthew Storey, MS: Apalachicola Rift, NE GOM
11. Jacob Miller, MS: SE Caribbean
12. Benjamin Miller, MS: Saba Bank, NE Caribbean Sea
13. Maddie Bishop, MS: Sandino Forearc Basin, Nicaragua and Costa Rica
14. Bryan Moore, MS/Post-Bacc: GOM and Atlantic conjugate margins
15. Sarah Meyer, Post-Bacc: Mapping of South Atlantic volcanic margins using gravity and magnetic data
16. Tarek Galhom, MS: offshore Morocco

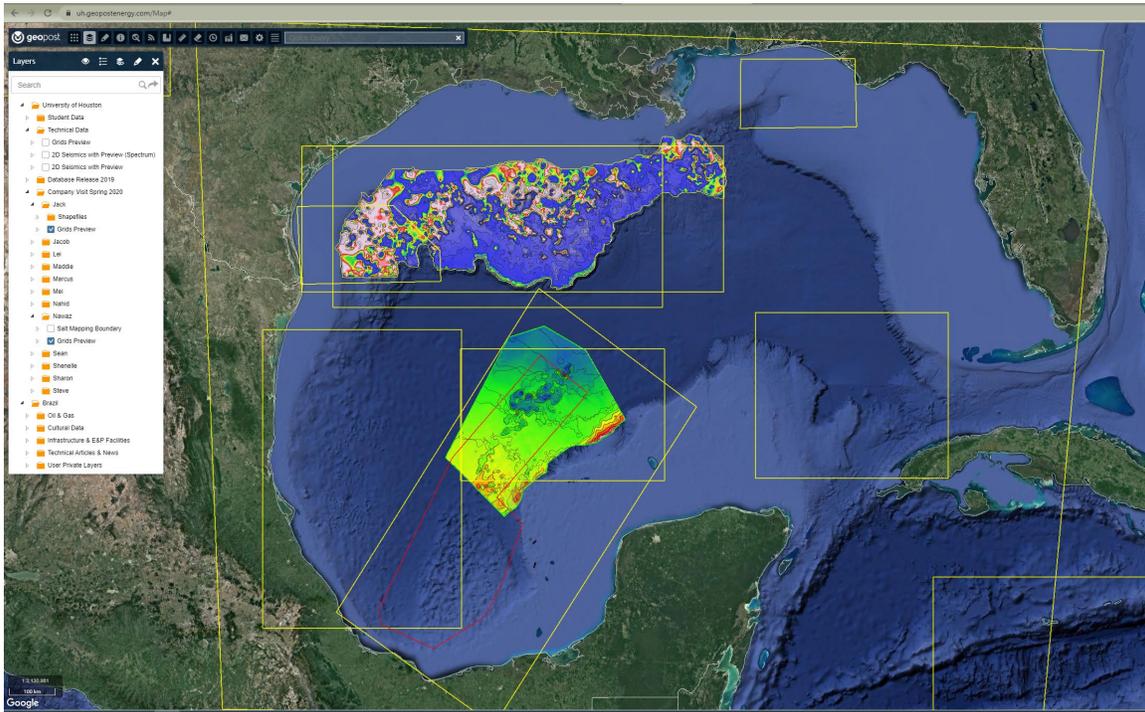


Figure 2. Gulf of Mexico projects and selected surfaces viewed in Geopost.