Daring to Find New Oil and Gas Reserves

Alfredo E. Guzmán

AAPG Annual Meeting, San Antonio Texas

Discovery Thinking Forum

April 2008

¨Exploration is not solely an intellectual problem.

In a more complete form, it is a sequence of

imagination and conventional daring, followed then

by intellectual confirmation, and finally put in play by

guts and drive and determination.¨

John A. Master

¨ The Art of Exploration ¨

Houston Geological Society Bulletin, Nov. 1996

Feature Article

The Art of Exploration

by John A. Masters, President, Anschutz Exploration Corporation

I have been exploring for oil and gas, and minerals, for 45 years. It seems like a long time, but it isn't. Watching 100 feet of uranium core being pulled out at Ambrosia Lake, the discovery of the biggest uranium deposit in the world—it was just last week. I remember how hot and dusty it was. That was New Mexico in July 1955. I was 28 years old.

I don't look back on those past days in New Mexico as a bygone era because for me geology and exploration have not changed. They have been a love and an obsession, and I suppose they always will be.

I have been in many plays and known some great explorationists. In a sense, I have learned more about exploration from them than I have from the geology itself.

For 20 years I worked for Dean McGee who found the great Oklahoma City field for Phillips when he was 29 years old. He moved downdip and drilled the truncated Simpson sands. And then, by his own single genius, he opened up the offshore oil industry, drilling the first well in open water at Block 32, Ship Shoal. He was a creative man. His benediction to me, a few months before he died, was "John, you are doing the most important thing a serious man can do. You are creating wealth. And thereby you are giving careers and lives to many others." I was a close friend of Mac McAdams who led Shell into Elk City, the Denver Basin, Michigan Basin, Block 69 Main Pass, and finally into the deep water beyond 1,000 feet. It was his greatness to see the fields and the technology moving out into really deep water. He was the first man in the petroleum industry to see that and move decisively. History has forgotten the hundreds and hundreds of geologists and engineers, and analysts and economists, who said he was wrong. Anyone with a really new idea becomes, in our world, an unpopular minority of one.

I work with Gerry Loucks who found the first field in the Wyoming Overthrust belt at Pineview. I have been fascinated to know and to read about other great geologists like Wallace Pratt, Lewis Weeks, Mike Benedum, Hollis Hedburg, Kip Harper, and Max Steineke. I am inspired by these people. They are my heroes.

Every day for 45 years, my thoughts have been focused on exploration and also on the best explorationists. I have known enough of them to realize that you cannot characterize them by a few, simple personality traits.

We do know that, among thousands of geologists, only a few find big fields. What is the secret to this? It is the most critical question in the oil business because it is what makes companies.

I will not pretend to you that I can define the secret, but I *know* that more is involved in exploration than mere technology. *More, I repeat, is involved in exploration than mere technology.* Unless you grasp this reality, you will not progress far in reaching for the secret.

Christopher Columbus made perhaps the most important discovery in the history of the world. But he didn't do that just because he was a good sailor. Very importantly, he was also a dreamer, a romantic. By the standards of normal behavior he was half mad when he sailed off the edge of the world

Roald Amundsen reached the South Pole for the first time—for the first time in the history of the world. It was 70° below zero. He wore a canvas jacket and leather gloves. Many of the great adventures of history were done by people who were, by normal standards, nuts. When Mike Benedum went into the Magdalena Valley in Colombia and found Las Infantas in 1917, he was nuts. When he made the first discovery in West Texas at Big Lake, he was still nuts. Benedum was nuts so many times that he compiled the greatest individual discovery record in the history of the oil business. Now think about this: he was not a geologist. He was a land man for Standard Oil for a short time after a few years in a one-room West Virginia school house. H.L. Hunt from Dallas built the greatest fortune in America finding oil fields, and his only professional skill was poker.

I repeat again: more is involved in exploration than mere technology. This concept

AAPG Memoir 38

- Elmworth - Case Study of a Deep Basin Gas Field

The discovery of a major oil or gas field onshore in North America is a significant event to geologists. But, the discovery of a supergiant field in a "subtle trap" is so unique that it fulfills the fondest hopes of all explorationists and confirms their faith that the earth holds hidden treasures that cannot be known by statisticians or economists. It is also of major economic importance because of the quantity of hydrocarbons involved and the fact that it opens many minds to other similar accumulations.

Elmworth contains 17 tcf of proved plus probable gas and 1 billion barrels of natural gas liquids with a huge adjoining area which has been only lightly drilled. The field is already known to be the largest gas accumulation in Canada and ranks as one of the largest in North America. Its size and its puzzling trap characteristics make it a worthy subject for careful geologic study.

Ten years ago it would have seemed scientifically irresponsible to suggest that Canada had yet to see its largest gas field and that it would be found in a stratigraphic trap where gas lies downdip from water with no impermeable barrier between. Rational analysis of the future is always constrained by limited knowledge.

Following the discovery of Elmworth in 1976, and extensive development over an area of 5,000 sq mi (12,950 sq km), the upside down trapping conditions of the "Deep basin" have been absorbed into the exploratory thinking of the industry. Similar conditions have been recognized in the tight gas sands of the Rocky Mountain basins, Arkoma, Appalachian, and various foreign basins.

In 1982, Dietrich Welte observed to me that Elmworth represented the largest field and the newest collection of geologic and reservoir engineering data on a tight sand, deep-basin type gas accumulation. Because of the sophisticated data requirements and collection facilities of the Alberta Energy Resources and Conservation Board, the very recent drilling history of the field involving the most modern logging, coring, and testing, as well as Canadian Hunter's high technology development practices, Welte felt that petroleum science would be advanced by an extensive presentation of the field information. Ted Beaumont of the AAPG gave enthusiastic support to the idea. Thus was born the rather unusual concept of a memoir to be formed of a number of papers largely from a single company. Justice demanded that Dr. Welte contribute his knowledge of geochemistry to the volume which he had suggested. I also asked Kam Chiang of Sundance Oil to write on the geology of the Hoadley gas field which is an Elmworth "look-alike" in the same Deep basin. All the other papers were written by Canadian Hunter specialists in various phases of Elmworth geology and engineering.

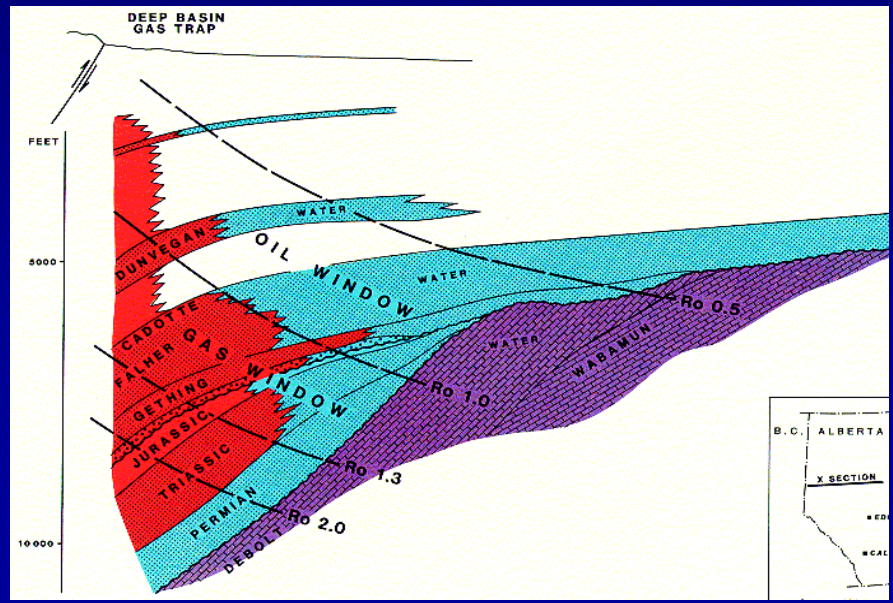
Every problem presents itself first in a blur of confusion. It is only after some amount of analysis that it breaks down into relatively simple components. Figure 1 gives a picture of the complex of information which we had to deal with initially and decide how to separate into manageable parts. The Elmworth field is a huge area of gas saturation 65 mi (105 km) long and 30 mi (48 km) wide within which there are now 250 recognized pools of commercially recoverable gas in 23 distinct stratigraphic zones. Southwest of a generalized water/gas contact the entire Mesozoic section from 3,000 to 10,000 ft (914 to 3,050 m) contains gas in every stringer of porosity; in fact the entire rock section is saturated with gas. The gas area has a total gas column of 3,000 ft (914 m). Updip, where the sands become more porous and permeable, the rocks are water saturated.

Memoir 38 deals with the generation and distribution of oil and gas in the Lower Cretaceous rocks; geochemistry of the rock section at Elmworth; stratigraphy of the Lower Cretaceous sands; detailed studies of the Cadomin and Falher reservoirs; reserves of gas at Elmworth; measurement of the gas contained in coals; pressure studies; electric log and rock calibrations; drilling and completion practices; and the geology of a similar field at Hoadley.

Finding a giant Deep basin-type gas field is technologically relatively simple, although statistically very rare. We prefer Mesozoic - Tertiary sands, of dominantly low permeability but with well-sorted marine shoreline sands present for moderate reservoir quality, adjacent coal or organic shales, adequate thermal maturity, located structurally deep in the basin, with sub-normal pressures, and anomalous electric log resistivity or, better, small recoveries of gas with no water. The techniques for recognizing the above characteristics are standard operating procedures for most geologists.

Exploiting such a field, however, calls upon some of the most advanced reservoir technology available and requires an unusual amount of coordination between the geological and engineering arms of a company. It is virtually impossible for one man to have all the skills required to analyze, measure, and produce these low-permeability, high-damage reservoirs, so a chain-link team of specialists must be available. Few companies have built, or can hold together, such teams. Perhaps the most significant contribution of this memoir, in fact, is its description of the several areas of expertise that must necessarily bond together in the exploitation of a major Deep basin-type gas field.

John A. Masters
Canadian Hunter Exploration, Ltd.

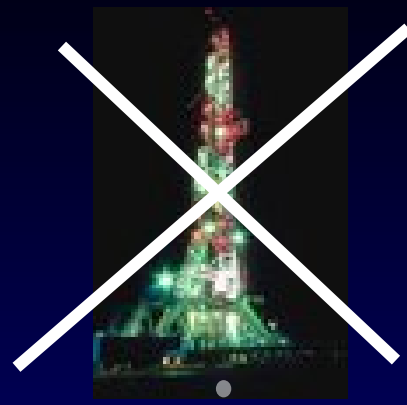


What does it take to discover new oil or gas reserves?

¨a working petroleum system?¨
¨having the right level of investment?¨
¨having capacity of execution?¨
¨having somebody with the training and insight to be able to interpret data to form an image of that reservoir in their mind so that a proposal can be made to test it?¨

Even with all these conditions met, many commercial reservoirs have not been discovered, because someone, at a decision making level did not feel that the opportunity should be tested.

Biggest Hurdle



Explorationists have to do what they do best!

When an oil finder is a proven one and has more control and authority, he or she will be able to test more opportunities, and in exploration the more times at bat, the better the chances of hitting a home run.

Exploration Drivers

- ✓ A sense of accomplishment in the *raison d´etre* of my profession.

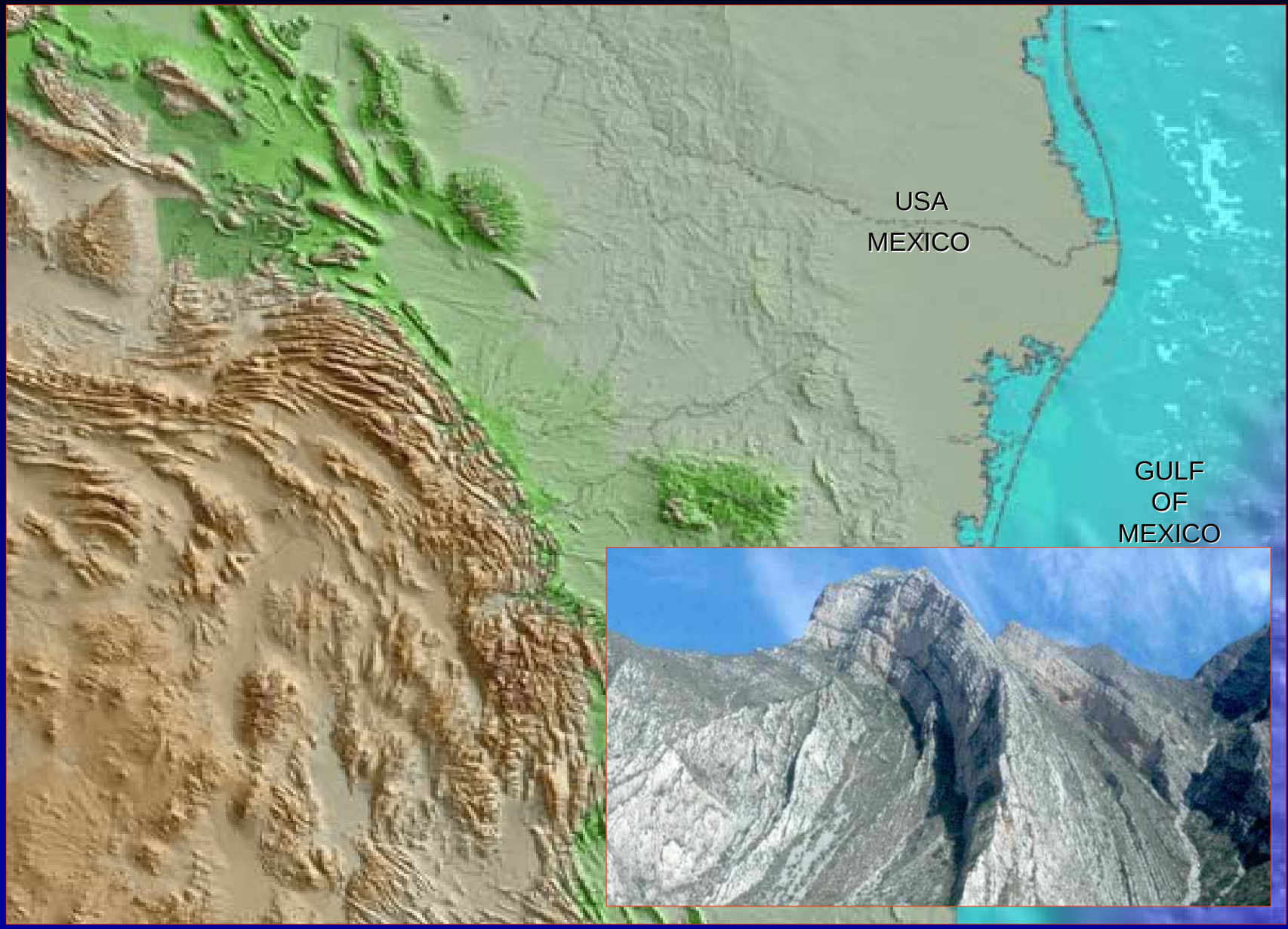
- ✓ To prove wrong ideas that go against the grain of what exploration is all about, such as;

  - ¨there are no more pools to be found¨

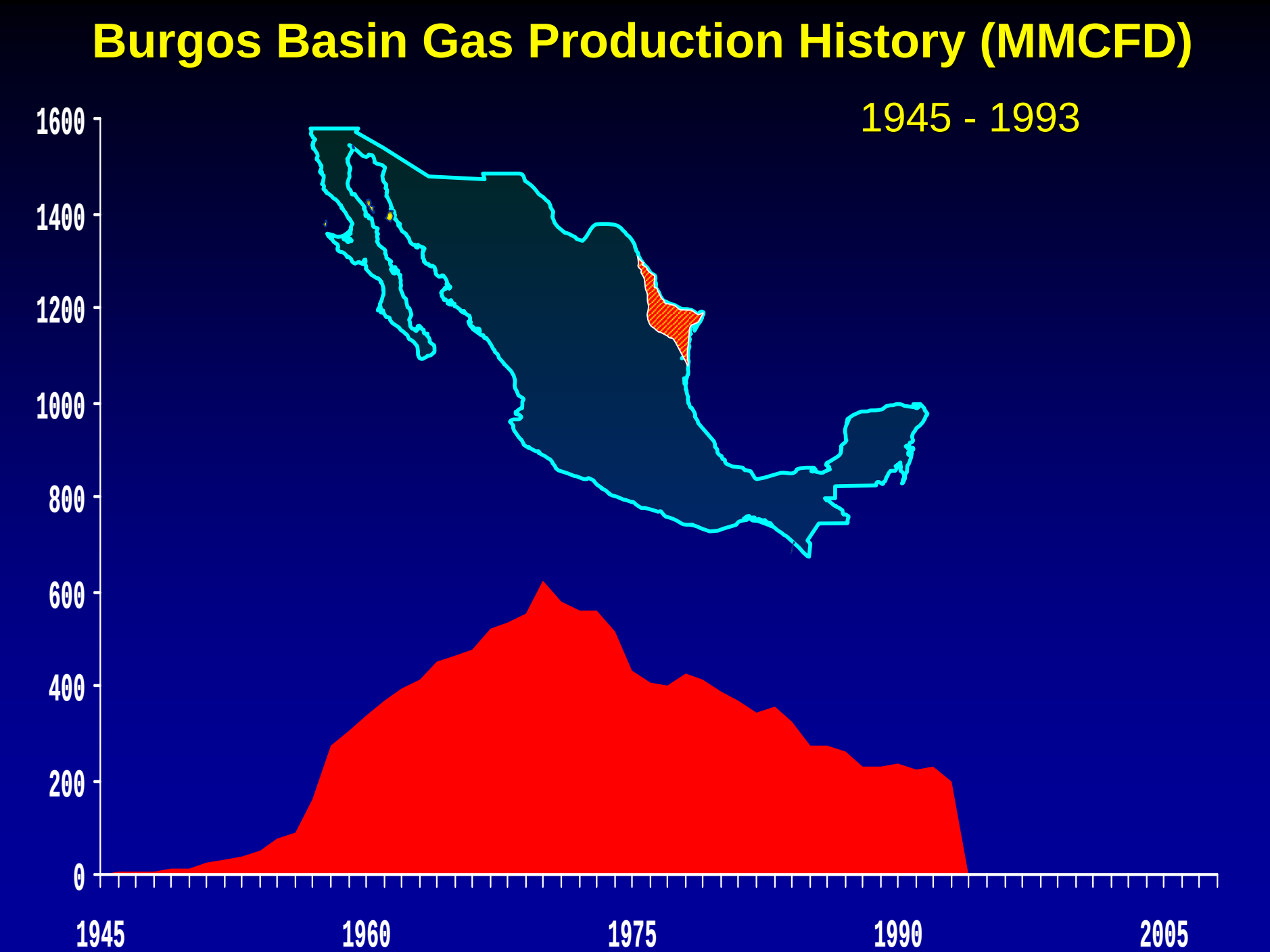
  -¨there is nothing left to do in this mature area¨

Sierra Madre Oriental Folded Thrust Belt

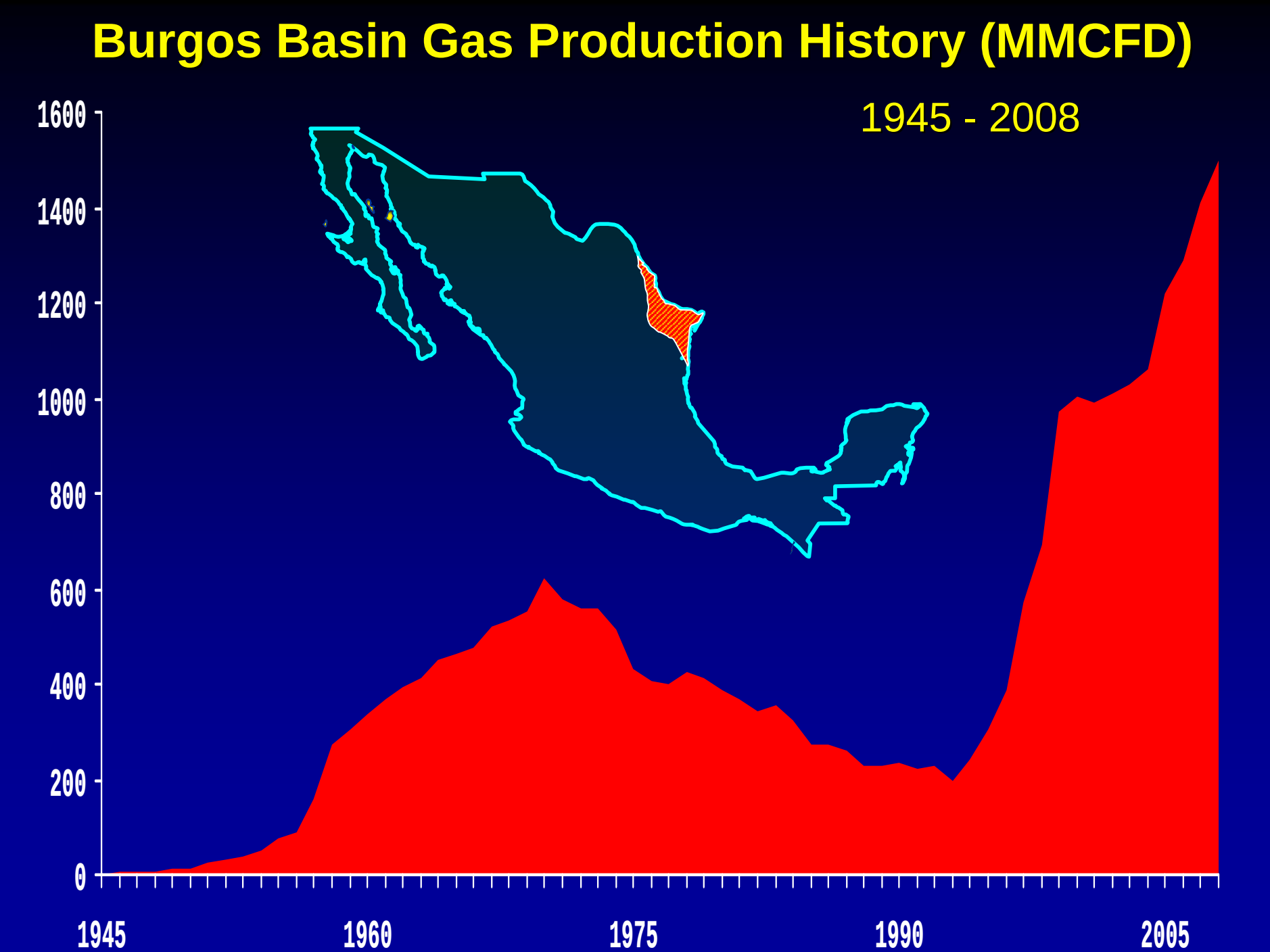
Doing Geology or Exploring for Oil and Gas?



Burgos Basin Gas Production History (MMCFD)

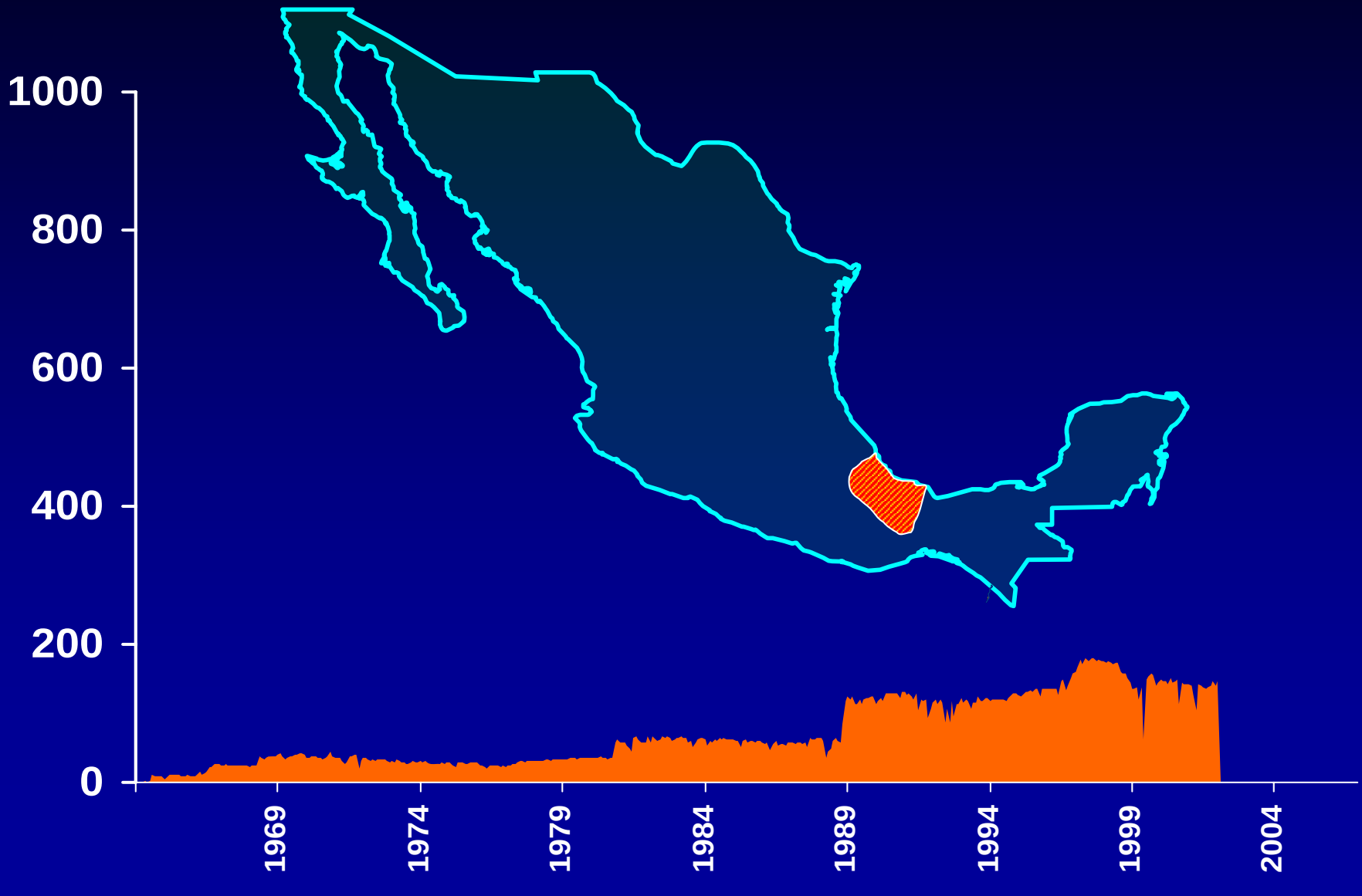


Burgos Basin Gas Production History (MMCFD)



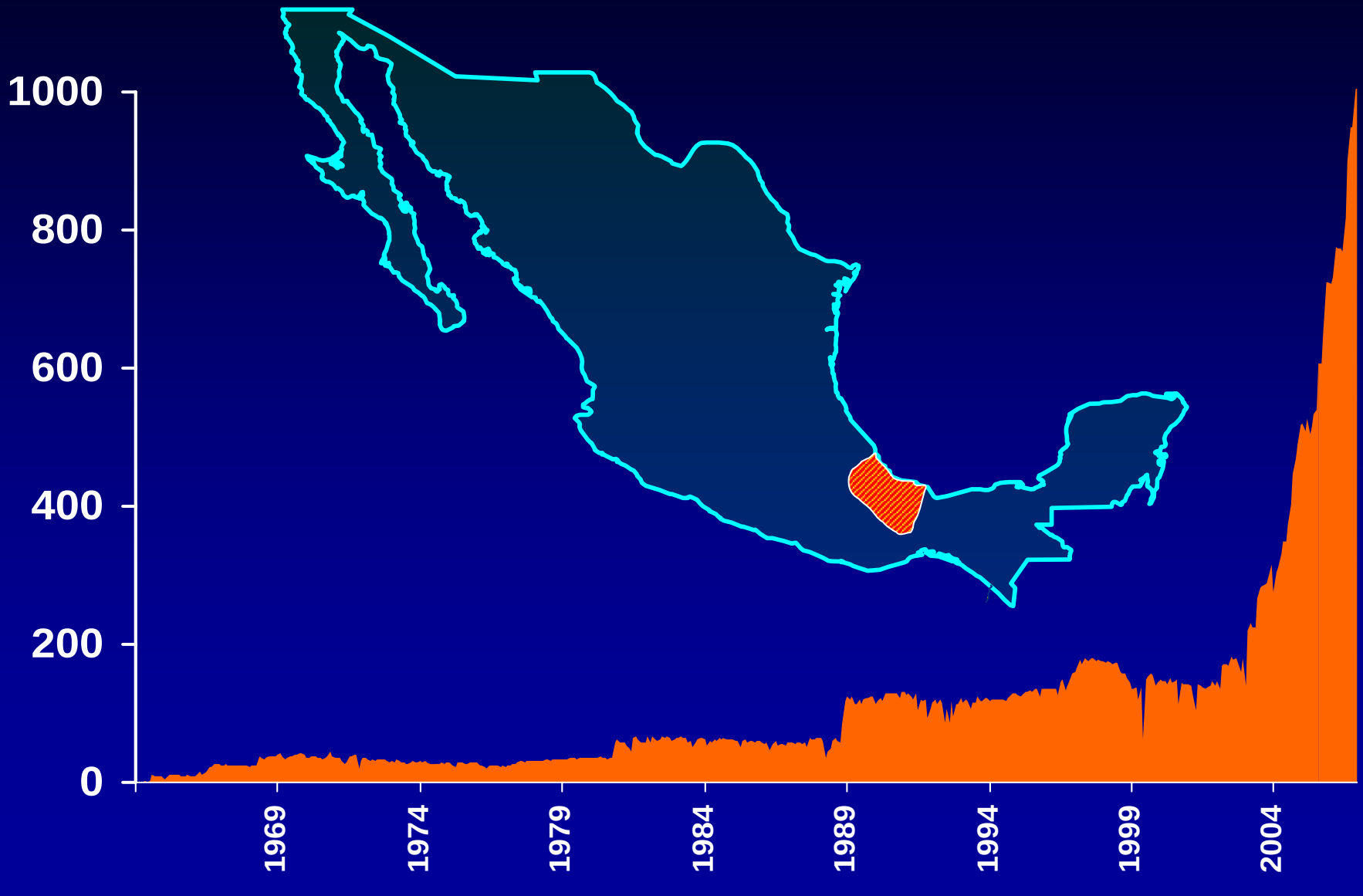
Veracruz Basin Gas Production History (MMCFD)

1962 - 2002



Veracruz Basin Gas Production History (MMCFD)

1962 - 2008



Closing Remarks

- ✓ Be more a generalist than a specialist
- ✓ Get in a decision making position
- ✓ Take risks

If you force your heart and nerve to accept these challenges and have the Will to say to them ¨hold on¨, then yours is the Earth and all the oil and gas that are in it and -which is more- you´ll be great petroleum geologists, my friends!.