OFFSHORE ENERGY CENTER HALL OF FAME

BOEM DEEPWATER GULF OF MEXICO HISTORY PROJECT

Interviewee:	Wagner Freire
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Interviewer:	Tyler Priest
Ethnographic preface:	Wagner Freire was born in raised in Brazil, where he completed five years of civil and nuclear engineering education in 1957. After graduation, Freire quickly joined up with Petrobras, the country's national oil company, starting out by progressing through a two-year course in the nascent field of petroleum geology. From that point, in 1960, Freire served in roles pertaining to both surface geology and seismic acquisition and mapping. In 1968, Freire was appointed chief geophysicist for Petrobras, where he pushed for the adoption of advanced seismic tools and data processing capacity. He oversaw the firm's first digital seismic survey, shot in the Espirito Santo basin; he also managed the company's later concerted efforts in the Campos Basin, which yielded major finds in the 1970s and 1980s.

TP: We're here today, the date is September 22, 2012, for the Offshore Energy Center Hall of Fame inductions. And we're with Wagner Freire, who is being honored as an Industry Pioneer. Congratulations.

WF: Thank you.

TP: Let's start talking about your early years, where you are from in Brazil, and how you got into this whole business.

WF: Okay. I'm very proud to be present for this celebration. I was born in the last century in a city, Belém, in the state of Pará. When I was seven, we took a ship and went to Rio de Janeiro. I was already educated preliminarily in Belém, but my whole education continued in Rio de Janeiro. I went to what we call Colégio Pedro Segundo, it's a traditional government school founded in the last century, and I was there for the

whole secondary school. My mother died when I was in secondary school, and I lived with a good uncle who guided my to high school, and so on. So, by 1956, after terminating the secondary school, I managed to go into engineering school, which was one of the best in Brazil at that time, and I studied engineering for five years. It is interesting, in my group we had two hundred people, two hundred students, and only four girls, four women. Now it is very different. We have at least 50 percent women studying engineering.

TP: I'm surprised there were even four women in 1956, you say, or was this a little bit later.

WF: I graduated in 1957. But in the last year, we had to decide what we were going to do . . .

TP: What kind of engineering did you study?

WF: I studied civil. But in the last year, they had specialization, and you had to select which one you wanted. They had five areas. I could go to civil engineering specialization. I could go to economics. I could go to highway construction. I could go to hydraulic developments. That period was more for going into highway construction. So my last year was highway construction.

TP: Brazil needed highways then.

WF: But, at the same time, I was challenged to go into nuclear engineering. So I went to the Brazilian research center . . .

TP: What was the research center?

WF: Centro Brasileiro de Pesquisas Physicas. They were educating nuclear engineers. So I made one year of introduction to nuclear engineering. In 1957 there was an appeal for that, because countries were considering using nuclear energy as an alternative to the use of weapons based on the fission of the atom. So when I finished engineering, I had two options: either continue in nuclear engineering, and then there was an appeal from Petrobras. Every year, Petrobras made a selection in schools in Brazil with a very competitive process. At that time, they had two possibilities. Either you could go to the refinery, construction, or you could go into a new field that was just developing at that time, petroleum geology. Back in 1957, there were no geology schools in Brazil. There were mining schools, but no geology schools.

TP: Like the one at Ouro Preto.

WF: Like Ouro Preto. Most people who went into geology at Petrobras, they came from Ouro Preto. The normal process was to send them after some time to study in the States, and then go back to Brazil. Caravalho Campos, for example, was typical, head of

exploration for some time, he came from Ouro Preto. When Petrobras was created, there was an educational contract to get an experienced geologist from the United States.

TP: Walter Link?

WF: Walter Link was contracted to work for Petrobras. He was really a very good geologist, a very good explorationist.

TP: Did you ever meet him?

WF: Yes, I met him several times. And his aim was to really make a very good team in Petrobras. It was his suggestion that Petrobras make a geology school in Brazil with foreign professors. And so there was an agreement with Stanford University. A Mr. Humphrey, Professor Humphrey, one of the heads at Stanford University, was contracted to head these geology courses in Brazil. So the decision was let's go to the geology courses. It was two years, full time, and then you go into geology. So I made these two years course in geology, headed by Professor Humphrey . . .

TP: Was he a petroleum geologist?

WF: A petroleum geologist. All the professors he contracted from the United States university, they came down to Brazil . . .

TP: They weren't all from Stanford, they were from different universities?

WF: No, different universities. There were about, I would say, ten foreign professors. And, of course, the lectures were given in English. All the reports in English. We had a beautiful geography, books to work with, so this was a very good course. I went to the second course, because the first course was only for engineers. In the first course, only 15 engineers were contracted. In the second, 15 or 18, and some of then didn't continue the course. So I graduated in petroleum geology in 1960. We had a beautiful letter from Mr. Link giving welcome to the new people. And I was immediately assigned to go to surface geology crew and I was supposed to be the second man. There was an American geologist that was head of . . .

TP: Seismic crew?

WF: Surface geology crew. They were mapping the Reconcavo Basin, and I was assigned to this geology crew. I stayed there for about one year, but after six months I decided to follow one of the steps that was followed by the engineer that came from the first course. The deal was here, after graduation in geology, he went into surface geology mapping crew, and six months later, he asked transference to go to a seismic crew. I did the same procedure. I asked transference to a seismic crew that was more related to my career as an engineer, in geophysics. It's funny, because after one year in the seismic crew, this guy wrote a letter to Link asking if he could make an M.S. in geophysics at

Stanford. And Link did authorize that, and he went to Stanford for one year. And I replaced him in the seismic crew. And, of course, after six months, again I made a letter to the head of exploration, I'd like to go to Stanford (laugh).

TP: Who was the guy ahead of you?

WF: At that time . . . Who? Carlos Eduardo de Moraes Fernandes. There is another story related to him because after a few years, he managed the first Brazilian seismic crew that was created by Petrobras. So I went back to my situation with the letter sent to the head of exploration in Petrobras. But Link had been replaced a few months before. The geologist responsible for exploration in Brazil, he sent me back a letter saying, "I don't think a geophysicist needs to make a master's degree course in geophysics." So I was frustrated, because I didn't get to go to Stanford for that purpose. But I avenged myself later, because when I became chief geophysicist with Petrobras, I sent five geophysicists, the best we had, to go to different universities for master's degree. I could not apply myself. So that was very frustrating. So I went to a seismic refraction crew that goes back to 1961. I started a career more related to geophysics. It is very interesting, because at that time, there was a giant field in Algeria that was discovered by refraction seismic . . . I think it is the Hassi Messaoud field . . . so I think refraction was indeed a very attractive method at that time.

TP: It is good for finding salt domes, right?

WF: And particularly, in Reconcavo Basin, that is an active basin, faulted, and the refraction could really give a good image of the basement, because of the velocity contrast. You have six thousands meters per second for the basement, and the Cretaceous sediments above. And I did make very good maps of the Reconcavo Basin with major trends well defined, and even Tucano Basin at that same time. So that was a major contribution for initial development of exploration in those basins. Of course, although in the Reconcavo, there had been oil production since 1939. But it was the contribution of the seismic refraction that gave a bump to the exploration there. Água Grande, one of the best fields in the Reconcavo Basin . . .

TP: What is it called again?

WF: Água Grande. It was discovered, based on reflection seismic, but it was a big field and the extent of it was defined by refraction seismic. So I think the contribution of refraction seismic at that time was excellent. And it provided me with the background for that. I was trying to remember the name of Wales. There was a British geophysicist called Wales. He was the author of one of the methods of refraction interpretation. So I applied his methods in Brazil.

But that was the beginning, and then I started my career in geophysics. Perhaps one of the first assignments given to me was training in Rio de Janeiro. There was a center, a processing center, analog . . .

TP: CENPES?

WF: No, no, no, in the Rio de Janeiro exploration department.

TP: Yes, that came later.

WF: That was run by United Geophysical. They ran a center for Petrobras. They produced analog seismic sections, reflection seismic sections. That, again, was very interesting. But I was assigned to make training in this center for about 3 months. And I was reading the literature and discovered that it was sort of an obsolete center. So I recommended two basic things. One that Petrobras be responsible for the processing. And second, to buy a modern analog process center. Only analog was made at that time. Analog processing. I recommended that we buy a modern center, run by Petrobras. But those things take time to move.

And then, we were in 1965. At that time, the North Sea was having a strong development. They decided to make a congress in Monte Carlo, called Le Petrol et la Mer, in which all the companies, geophysical companies, petroleum companies, were very much involved, because the North Sea was just beginning exploration.

So some of the modern technology was developed and introduced at that time, like the streamer cable for offshore seismic acquisition. The streamer cable, the air gun, Vibroshock, introduced by CGG, the French. The Americans introduced the air gun. So we didn't use anymore at that time, dynamite. And the beginning of digital recording. At that time, the most active companies at that time were GSI, Western, CGG, and Prakla, the German company. But the one that was the leading processor was GSI. They introduced a special tape of one inch. There was a big discussion at that time, and Western went with a half-inch tape. The same tapes they used in IBM computers. The big discussion was could we record with half-inch tape, the density . . . versus the density in one-inch tape. At that conference. There was a man from Western, he was a brilliant geophysicist, Carl Savit, I was impressed with his presentations and debates at that conference. There was an interesting point about the conference. Petrobras had a new president, we had a military revolution in Brazil, the military took over, and in 1965 the president of Petrobras was . . . Marshal . . . I forget his name, I will remember in a minute [Ademar de Queiros] . . . He said: "Is there anybody from Petrobras in Europe that could go with me to this conference?" And they said there is a young geophysicist taking training at CGG and Prakla, and he said: "please invite him!" So I went with the president of Petrobras to this conference. It was really extraordinary.

TP: Who held the conference?

WF: That is a good question. I can hardly tell that. Because it was in Monaco. There was no leading company at the time to promote such a conference. But I do have the book related to it. I could check on that. But it was a very important event. Because the

companies were really starting up the difficult exploration in the North Sea. One amazing thing about the North Sea, it was not very deep. As everybody knows, the first discovery was Ekofisk, on the border of UK, but in the Norwegian side, made by Phillips, Phillips Petroleum at that time, that was merged with Conoco later on. But that was the first discovery in the North Sea, that goes back to 1968. In 1967, we had that first discovery in Brazil, Guaricema, offshore, that was still based on analog data. But this conference in Monoco was very important because it attracted lots of companies. Again, this conference was '65, and this discovery was only in 1968, the Ekofisk. My participation in this conference called my attention to the whole field of technology that was under development. In fact, one of the challenging questions in the North Sea was that the companies could not drill throughout the year. They had to suspend operations. Remember, so much of the activities we had offshore were in the Gulf of Mexico in shallow waters. And so the companies were moving into a completely different environment. The drilling rigs were not prepared, and drilling activity were suspended for six months during the winter time.

If you are not having operations because of rough conditions for drilling, you have to put everyone to work in studying, making reports, and this changed after some time as they managed to make drilling rigs to operate in the rough seas. Again, the water was fairly shallow. Most prospects were 100-150 meters, not more than that.

So I think had a lot of influence in my thinking in how to behave, how to develop things in Petrobras. Of course, when I came back, I pushed even more the installation of a new processing center within Petrobras. It's funny, I don't remember now the name of the supplier, but we bought the best analog processing center, which happened to be the last one built by the industry, I would say.

TP: Last one built by who?

WF: SIE, I think. I company that made equipment. I think it was SIE, and American company. Then, in July, 1968 . . . well, beginning of 1968, I was appointed chief geophysicist of Petrobras. I started pushing even more the new processing center. Because of the difficulty relating to the import of equipment, it was installed in July 1968. At the same time, we already were talking to the geophysical companies to make surveys in Brazil, digital surveys with streamers, Vibroshock, and the other technologies. The first contact was made with Western Geophysical to start in the beginning of 1968, the first offshore digital survey in Brazil. That was made with Western. We made a tender, and Western submitted the best proposal. I remember talking to Carl Savit and even to the managers of Western – I was already in Rio – they said, the contract was made for 3,000 kilometers, 6,000 kilometers but with an option to suspend after 3,000 if things were not properly made. I remember the comment of the Western people, "those guys they want to make 3,000-6,000 . . . they are going to make 60,000 kilometers continuously, so let's get this contract!" So that was very funny, they said let's get the contract at a good prices, and we'll start operations in Brazil.

TP: Where was the first digital survey?

WF: The first survey was made in Espirito Santo. An interesting story about this Espirito Santo survey. Perhaps I should develop it right now. There was based on the old seismic that we had salt domes in the Espirito Santo basin. Then, the people from gravity – there were people from gravity, and people from seismic -- were pushing very much, they even made a long gravity survey from Campos to Bahia in shallow waters. This was not pushed by boats. But you put the gravity instruments in the bottom and move them. It was terrible. But the outcome of it, one guy in the gravity survey said, "this is not a salt dome, this is likely igneous rock. This is not a salt dome." He was very firm, like that. Then I read in a geophysical magazine about cross-shooting in seismic refraction to determine the velocity of the bodies. I made an agreement with Western to make a refraction survey across these dome-like structures. The results were fantastic. Because Petrobras had a drilling rig assigned to this dome to determine what it is. Then there was this question, "this is not a salt dome!" Then I made this cross-shooting I read about in this geophysical magazine from Europe, that was a new technology, and we found the velocity of this plug was 4 to 5,000 meters/second, the salt velocity. It was not igneous. Igneous was more than that. And the guys in gravity, they were still saying, no maybe it was a [unclear] plug. It was clear it was not even a shale dome. Because shale has a velocity of 2,000 meters. It was very clear. So I considered this an achievement.

Petrobras drilled the well. That was the first offshore drilling in Brazil.

TP: About 50 meters of water?

WF: Maybe less than that. It didn't find oil. But after drilling the side of the plug, they managed to hit the plug, and of course it was salt. It was a big celebration in Brazil because we do have . . .

TP: Salt features associated with oil.

WF: Like in the Gulf of Mexico, or in Texas.

TP: So that was a big deal.

WF: It was very good for Brazil. And then the rig moved to drill in Northeast Brazil, and that was Guaricema, and the was discovered in 1968. Anyway, as I said, in July 1968, we installed the most modern analog processing center. Then I started talking with Western, "why don't you put a digital center in Rio." "Oh, why not?" So, at that time, because I had a strong position in the company, I managed to contract IBM 360/144 scientific model computer. We managed to install it and make the programs everything. The center was installed in December 1968, six months after, everything was moving much faster. This was a really fantastic move. Then we started changing the technology, introducing new technology for digital, as all the other companies were doing in the Gulf of Mexico or North Sea.

TP: This leads to another question. Did Petrobras use Bright Spot interpretation, and, if so, when?

WF: Immediately after, yes.

TP: You mean, after Espirito Santo.

WF: After Espirito Santo, yes. Not at that time. What happened was that one of the basins considered important at that time was the Amazonas basin. The analogy was that it was like the Niger. But we really didn't know what kind of sediments we had in the Amazonas. But we contracted the first digital survey in the Amazonas mouth. That was maybe the later part of 1968. I don't remember now. There was an interesting problem: how to locate the boat, the seismic ship. At that time, the seismic ships were located by triangulation of onshore signals, by radio signals. There were no satellites at that time. So the location of the seismic ship was not easy. They had to use three stations, transmitting radio signals to the ship. And then you could locate. When this was made in the Amazonas, there was a problem because the signal could not propagate. The survey was maybe 100-200 kilometers from the different stations along the coast, and the signals could not propagate, could not be detected. And then, you know there was always the political issue, they said, "the Americans, they don't want us to find oil in Amazonas!"

They worked hard on that. The reason was because of fresh water in the Amazonas. The signals couldn't propagate because of the presence of fresh water for a long distance. The Amazonas River brought a lot of fresh water, and the signal could not propagate because of that.

TP: The triangulation signals?

WF: The triangulation. They had to make immediately strong signal with other approaches, and they managed to locate. The first surveys were made precariously, because the location was not very good. But interesting, we found a beautiful Bright Spot in the area.

TP: By this time, you knew what Bright Spots were.

WF: Yes, it was in the literature. I don't know when it was, 1968 or 1969.

TP: What did you call it, because the term "Bright Spot" wasn't even evented then, I don't think.

WF: I think it was already called Bright Spot. Yes. Maybe I'm wrong about the year.

TP: It was 1970 that Shell started bidding in the Gulf of Mexico on Bright Spot.

WF: So it was around then. Maybe it was not the first survey, but the second. By the way, because we could not locate properly the boat, we made some lines, but we moved the survey to another area in Brazil until we solved the problem of location. It is interesting this discussion about location. That was a weak point in the industry. But immediately after, the satellite started to become a point of control for that. I don't know if it is well know, but in the North Sea, when you made a good prospect to be drilled, usually when the drilling rig went to the place, they made another seismic survey in the area to be sure that the rig was in the proper place, because the accuracy of the survey was not good enough. It's funny this had to be done. So in the beginning of the 1970s, they were still doing things like that in the North Sea.

So, then, we started moving on the continental shelf in Brazil. There was a discovery in the Sergipe Basin, Guaricema. Then we intensified the surveys in the Campos Basin. History indicates that there were seven dry holes in the Campos Basin before with some influence of French geologists, saying "you have good chances for the Albian prospects like you have in Angola and other places – the carbonate Albian prospects – why don't you look for them?

TP: Who were the geologists, French geologists?

WF: From Total. No, not Total. Elf-Aquitaine. They were involved in other areas.

TP: So they came to you?

WF: No, they came to Petrobras exploration department to talk generally about the possibilities in West Africa and things like that. So we already drilled six dry holes. And they said, "why don't go you deeper to try to find the carbonates in the Albian?" And we went deeper, the number nine well – interesting, when they almost reach the carbonates there was a failure in the well – it was a new rig, we had to decide whether to make a second well, or not. Forget that. We made a second well, and the second well was the discovery of Garoupa. Garoupa was discovered in the Albian carbonates. And again there was a lot of excitement within Petrobras like with the salt in the Espirito Santo Basin, because if you have carbonates in this very important reservoir, let's send some people to Mexico to talk to Pemex about discoveries there, let's send to the United States, bring some professors. So there was a lot of movement.

TP: Was that drilled on a Bright Sport or amplitude anomaly?

WF: No, it was not a Bright Spot. It was just a normal . . . because Bright Spots are usually associated with . . . the one in the Amazon is a typical example of Bright Spot, because you have the structure well-defined and then you have a horizontal layer well-defined, because the contrast between the water, the flat position of the reservoir. With Garoupa, there was just the structure.

What was the second point? The second point was that we drilled an extension of the Garoupa field to find again the reservoir that they expected to find in the carbonate. Surpisingly, this was dry, dry in the carbonate. So, you know, carbonates they change properties quickly. And, there was some indication in the upper Cretaceous of some oil, but this was not considered the point, this is not what you want. You want to have the Ablian, not the upper Tertiary. And this upper Cretaceous happens to be the Oligocene reservoir that was found years later in the Marlim field. This is very important. At that time, it was a bit neglected, because Petrobras was looking for the carbonates. Where are the carbonates? So Garoupa has this story.

TP: But the original discovery was in the carbonate, and when they tried to delineate it, it was dry.

WF: The extension was dry. Despite that, it was a good discovery.

TP: But they did not pay attention to the upper Cretaceous. When did they go back and drill that?

WF: What we did next was to say, "how do we develop the Garoupa field?" It was not 500 million, but maybe 120 million barrels. Recoverable reserves. Much smaller than a giant field. So Garoupa was smaller . . . But after the Garoupa discovery, we moved deeper and started to find other fields in the same area. Garoupa was 120 meters water depth. The other fields were 150 meters.

TP: Namorada?

WF: Namorado. Several other fields were discovered at that time. Campos started looking like a very important oil province. But all the discoveries at that time were not too big, but important.

At that time, technology for development was not well known in Brazil. Then we started talking to companies operating in the North Sea to bring that technology to use in the Campos Basin. So we could make a fixed platform, of course, because the depth was 100 feet, not more than that. And so development was made with a fixed platform. But fixed platform takes time. Particularly at that time, because everything was imported. By the way, once they were bringing a derrick, not a derrick, but a part of a platform . . . a . . . a

TP: The template, the steel jacket?

WF: The jacket! They were bringing the jacket, that was made in Scotland to Brazil. And it was sunk! It sunk in the North Sea. So we had to build another one. There are a lot of stories about that. So people say that is was mis-designed, or the design was not made, so some people decided to sink the jacket.

TP: So Petrobras contracted for a jacket for Garoupa initially?

WF: In all the fields. They contracted for about seven fixed platforms. Because several fields were discovered at that time. But it takes to develop, to drill, everything, it takes time.

The other important factor related to it was – and some influence I put on it – in the later part of the 1970s, beginning of the 1980s, I think it was 1979 . . .

TP: Braspetro?

WF: Braspetro was founded before. The discovery of the Enchova field. Enchova was discovered, I think, 1979 . . . Enchova field? But there was a very important discovery and that was Enchova. Let's see, Enchova was . . .

TP: Well, we can find that. I had it down here somewhere.

WF: . . . already in the 1980s. Anyway, testing Enchova produced 10,000 barrels a day. Enchova was discovered in January, this beautiful testing was made in January. And then, key people in Petrobras started talking to the drilling companies, and at that time the Argyll field had been discovered in the North Sea, and Sedco, they made a Sedco platform, drilling platform, adapted for discovery . . .

TP: An FPSO.

WF: This Argyll had 98 meters water depth, but it was not a big field. So, they decided to use a drilling platform adapted . . .

TP: Okay, so a semi-submersible that was adapted for an early production system.

WF: I think this was '85. I can check, later on. Those people who were in Sedco started talking to some key people in the production department of Petrobras and said "why don't you make this Enchova field?" So they decided to talk to Sedco, again, and they started developing a system to start production of Enchova. And this 10,000 barrels of day was made in January – I was not in this area, but a new a guy involved with that – and in August of the same year, Enchova started producing, in six months time. You see, it would be impossible to have something like that in Brazil, nowdays, because of environmental . . .

TP: I think it was 1977.

WF: '77, right! 1977.

TP: And used wet tree subsea technology.

WF: Wet tree. And then, this is part of the technology development for deepwater. This was the first production in Campos Basin. You know, the construction of the fixed platforms were going on, but it would take 2-3 years time to have them implanted. But first production came quickly from this system. No sophistication at all, and very practical. There was no contribution of Petrobras research center, by the way, because none existed! It was the people in charge of operations who devised that. And that time, I was already in the international area of Petrobras. I was the exploration and production manager of Braspetro, and I pushed to have some participation in Norway. It was not easy to qualify Petrobras to operate in Norway. But with this development of Enchova, we started also, well . . . "we know at lot of technology." We even managed to create a company, I created a company, called BrasNord together with a Norwegian service company to sell technology to the Norwegian companies. To develop fields in Norway. My God!

And at the same time to qualify Petrobras to operate in Norway, it was not very easy. Again, I think I had an important role in trying to sell Petrobras technology abroad. I didn't get much support from the headquarters, by the way. I was in Braspetro, not Petrobras. The development of those what we called "early production systems" for Enchova and the others, then started working for the other projects, including those that would have received eventually the fixed platforms. The technology was based in a few things. One quick point, important point, was flexible pipes. And flexible pipes were developed at that time by Coflexip, a French company that had participation of Total and the French research center. I forget the name. But they developed the technology of flexible pipes. And those flexible were used in Brazil for the first time together with other developments in deepwater. Floating production platforms, drilling platforms, semi-submersible drilling platforms, together with flexible pipes, and subsea completion. We started working subsea completion at that time. So those three elements were key to go into deepwaters.

TP: I think we are running out of time. We got up to deepwater. I'm going to have to spend more time with you.

WF: Maybe we should try to cut down the time. What happened after, I did develop a lot of activity in the international area.

TP: I wanted to talk about Iraq and Majnoon.

WF: Yes, there is no time for that.

TP: You and I can sit down together another. This is great. This is a fantastic interview. Thank you for taking the time to be with us.

WF: I wrote recently for a book that is going to published. Maybe I can send to you for reference.

TP: Yes, you gave me a bunch a materials already. Anyway, I'm going to be at your table tonight.

WF: Yes, that is going to be very important.

TP: Thanks again, Wagner.

WF: Thanks for your attention.