

The Development of Sonic Drilling Technology

A historical review from its origins in the late 1940s.

Much of the credit for the successful introduction of sonic drilling technology to the drilling industry is due to the continuing efforts of Ray Roussy, P. Eng., who is currently the president of Sonic Drill Corp. and of Sonic Drilling Ltd. Sonic Drill Corp. (www.sonic-drill.com) is based in Bellingham, Washington, US, and Sonic Drilling Ltd. (www.sonic-drilling.com) in Surrey, British Columbia, Canada.

Mr. Roussy has spent his entire career in the drilling industry. After graduation from technical college in 1969, he worked for a major diamond drilling equipment manufacturer for three years before deciding to return to university to obtain a bachelor's degree in mechanical engineering. Upon graduation in 1974, he started working for Hawker Siddeley as a design engineer in its newly formed sound dynamics department. Hawker Siddeley, the well-known British aircraft manufacturer was, at that time, interested in broadening its product base.

Hawker Siddeley had purchased the rights to manufacture a range of vibratory equipment from Dr. Bodine of the Bodine Soundrive Co. in California and wanted to set up a research and development group to work on this type of equipment. The goal was to eventually market machinery based on vibratory technology for various applications such as civil construction.

The original experiments aimed at using vibrations to drill holes in the earth started in the late 1940s. The initial goal was to speed up oil well drilling operations and most of the research was financed by the petroleum industry. The best funded and documented of these efforts was the work of a US-based company called Drilling Research Inc. (DRI), which was in operation from 1948 to 1959. It developed a magnetostrictive-rotary-vibratory drilling system. This method was not successful but it demonstrated that vibrations could speed up rotary drilling rates substantially. At that time work was also underway in Russia on a 'vibro-drilling' system, which was reported to have drilling rates of three to 20 times those of conventional rotary drilling.



A recent demonstration of sonic drilling in Tokyo, Japan.

Note the soundproof enclosure around the drill head to minimize noise level.

Early Work

During this early period, Dr. Bodine worked with Borg Warner on a down-hole vibrator, which he called a 'sonic drill.' It failed because excessive vibratory energy caused mechanical failure of the down-hole components. Later on in the 1960s, Dr. Bodine developed a much larger top-hole vibrator with the support of the Shell Oil Co. The machine was intended to be used for oil well service work such as pulling stuck casing and rehabilitating oil wells. Bodine received many patents in the 1960s for his work.

His large vibrator had a capacity of up to 1,000 hp but suffered from poor reliability. It was tested extensively as a possible high-speed pile driver. Bodine's group had also started to develop a smaller oscillator when his equipment was sold to Hawker Siddeley in the early 1970s.

When Hawker Siddeley first looked at this equipment, it was rapidly realized that the funds required to develop a reliable high horsepower vibrator for pile driving would be prohibitive, considering the small volume of machines that could eventually be sold. The advent of the modern diesel pile driver hammer also discouraged any further development of the high frequency vibratory pile driver.

Ray Roussy and his associates then decided to try to see if the smaller vibrator could be used for drilling purposes. A basic drill rig was designed and constructed in a hurry as a major oil company wanted to see if this vibratory machine could be used as a seismic drill. The oil firm had an urgent requirement to place blasting charges in some 150 ft. of wet clay and sand beneath frozen lakes in the Arctic. The machine proved successful in this application and a few rigs were then built to work in this field for a few years. Major oil and gas discoveries were made in the Mackenzie Delta at that time, but this activity came to an end in 1977 as a result of a 10-year moratorium imposed on oil and gas development in the Arctic.

Interestingly enough, this activity has resumed recently as a pipeline is currently being contemplated to bring oil and natural gas from Alaska and the Mackenzie Delta to markets in Canada and the US. The US now wants to become more energy self-reliance and Sonic Drilling Ltd. resumed sonic drilling again at this very same location in the winter of 2001/2002, some 26 years later.

The early rotary-vibratory drills, or 'sonic drills' as they were called, were not configured specifically as drill heads. They were basically oscillators that were modified for drilling. The machines were very unreliable and prone to frequent breakdowns. These earlier sonic drills were using currently available 'standard' drill tooling which was not designed to take the high frequency vibratory loads imposed by the sonic drill. The result was frequent breakage of drill tools. Nonetheless, the rotary-vibratory technique demonstrated that it had great potential in the drilling industry.

Sampling Capability

It was discovered during early experimentation that, in addition to being capable of drilling holes rapidly, the machine had an outstanding ability to take truly representative continuous cores of almost any overburden material. It was also able to core through boulders and into bedrock. In fact, it has shown in later years that it is capable of drilling through almost any material, including solid steel plate, ships propellers and almost any item that could be found in a landfill site.

In the late 1970s and early 1980s, gold prices were relatively high and there was a lot of placer gold exploration (gold nuggets or flakes found in sand and gravel deposits is designated placer gold) going on in British Columbia, the Yukon Territories and in Alaska. The sonic drill proved to be excellent at recovering placer gold core samples and a number of machines were built and used in this application until gold prices collapsed in the early 1980s.

The severe recession of the early 1980s discouraged Hawker Siddeley from continuing development work on sonic drill technology. However, Roussy felt that this technology had a lot of potential if the equipment was developed properly. By this time he had tested the sonic drill technique in various applications and he knew that it was a superior way to drill holes in overburden and for taking core samples. He was certain that the technology had a very bright future. In fact, he considered it to be the only true innovation to come to the drilling industry since the Chinese invented cable tool drilling some 3,000 years ago and decided to spend the rest of his career in promoting this technology. He felt that, in time, sonic drilling would become the method of choice for most shallow earth drilling applications. For example, he had seen that one sonic drill could do as much drilling and sampling as three or four auger drills during the same time period.

Roussy decided to form a contract drilling company to continue development efforts and to promote the use of this technique. That company — Sonic Drilling Ltd. — was formed more than 20 years ago and is still in operation today using sonic drills exclusively in various applications. This has allowed Roussy to carry out long-term durability testing of sonic drills and related drill tooling in the real world before offering the technology to the drilling marketplace.

Before shutting down operations, Hawker Siddeley had sold a few sonic drill heads to Midwest Drilling of Winnipeg, Manitoba, Canada. Other than Sonic Drilling Ltd., this was the only other user of the technology in the early 1980s. Midwest had built its own rigs and used the machines to take core samples of mineral deposits for the mining and exploration sectors. Roussy continued servicing these machines and upgraded them to make them more reliable.

He then began extensive testing, redesign and re-testing of various components of the sonic drill head until he knew that he had a reliable prototype drill head. However, he was not satisfied with the configuration of his early prototype and wanted to eventually re-design the sonic head to make it more suitable for the job. Most of his experimentation was carried out using a prototype drill rig, which is still in operation today. He has received a number of patents that cover improvements to this technology.

Environmental Drilling

In the early 1980s, the environmental drilling sector started to become active in the United States and was also destined to take off in Canada a few years later. A Minnesota based drilling company — North Star Drilling Inc. — had had some interactions with Midwest Drilling. The president of North Star Drilling was suitably impressed with the sonic drill's ability to take continuous core samples and felt that this technique could be used to an advantage in the environmental drilling field.

He started using a sonic drill for a few projects and later on became very successful at using the technology for this application. That is how sonic drill technology was first introduced to the US. North Star Drilling then started leasing all of Midwest Drilling's sonic drills, and also purchased two more older style sonic heads from Ray Roussy.

In the early 1990s, Boart Longyear's (BL) US company, based in Salt Lake City, Utah, and one of the world's largest drilling contractors, became interested in the potential of sonic drilling technology. It eventually purchased the drilling business of North Star Drilling as well as the drilling rigs that used to belong to Midwest Drilling. These assets were merged with those of another environmental drilling company that Longyear owned to form the environmental drilling division of BL.

Thus began a long association between Ray Roussy and the environmental drilling division of BL. Roussy then sold BL four more of the older style sonic drill heads and subsequently sold them more modern versions of sonic drill heads. BL continues to be a leader in the environmental drilling business with its fleet of almost twenty sonic drill rigs.

Roussy also introduced the sonic drill to the environmental drilling industry in Canada in the early 1990s. The machines have so many advantages in this application that the demand for sonic drills in that industry continues to increase.

The activities of BL in the US and Sonic Drilling Ltd. in Canada have attracted the attention of other drilling companies. Although they sat unused for a good part of the early 1980s, most of the older style rigs that Roussy and his associates had constructed at Hawker Siddeley went through a series of owners, such as Water Development Corp. in California, before ending up in the hands of Prosonic Corp. (formally Alliance Environmental, Inc.) of Marietta, Ohio. Prosonic is also a major user of sonic drills in the US.

Further Improvements

In the early 1990s, Bowser-Morner, another prominent drilling company located in Dayton, Ohio, became interested in this technology. An arrangement was made between Ray Roussy and Bower-Morner, whereby Roussy would design, build and test the first sonic drill head incorporating his many improvements and configured specifically to suit the drilling industry.

Bowser-Morner selected Versa-Drill International Inc. to build a rig that would incorporate Roussy's new sonic head. Versa-Drill is a progressive drill rig manufacturer based in Indianapolis, Indiana. This new machine, called a 'Versa-Sonic' drill rig, was first put into operation in 1997.

NEW TECHNOLOGY

That first machine is still in operation and others have been produced for Bowser-Morner and other drilling contractors. Bowser-Morner has been very successful with its machines and continues to be a leader in the use of sonic drilling technology.

Other sonic drill rigs using Roussy's sonic drill heads have been built by Acker Drill Co., Scranton, Pennsylvania and Gus Pech Mfg. Inc., Le Mars, Iowa. All of Gus Pech's rigs were produced for Boart Longyear.

Over the years, a number of other companies have attempted to produce smaller rigs using vibration in one form or another. These have ranged from oscillators that operate at low frequency and do not rotate to small cement vibrators modified to carry out drilling operations. These manufacturers have invariably used the term 'sonic drill' to describe their machines in an attempt to capitalize on the interest generated by true sonic drill technology.

Roussy's new sonic drill head is twice as powerful as the older machines. It can function as a standard air or mud rotary drill head in addition to having the added advantages of much faster drilling and an exceptional coring ability. Roussy has now built a sonic drill rig designed specifically to take full advantage of his sonic drill head. After many years of thorough field-testing under real world conditions, he is now ready to offer to the market the complete package of sonic drill head, drill rig and drill tooling. He has also signed an agreement with a prominent Japanese drill rig manufacturer, Tone Corporation, located in Tokyo, (website: www.tone.co.jp) to introduce this technology to the Asian drilling market.