The story of Wolfspar®, BP's low-frequency marine seismic source; or*,*
"Sometimes the 'brute force' approach to a problem can work"!

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In exploration seismology we image the Earth's interior using reflected sound waves. We do this using an algorithm called "migration", which converts the reflected sound waves recorded at the Earth's surface into an image of subsurface structures. There is a catch-22 problem in doing this, however. For migration to work we need a reasonably good numerical model of the sound speeds in the Earth. We often find ourselves trying to guess what those sound speeds may be. If our guess is not too far wrong, it allows us to produce a degraded image, which we can then use to update our subsurface sound speed model and try migrating again, etc. Sometimes, however, we just can't get this process off the ground.

The standard response when confronted with such difficulties is to construct ever more sophisticated imaging / inversion algorithms. The holy grail would be an algorithm that could produce a good image with minimal to no human intervention or a-priori information required. Some of the best minds in the industry have been working on developing such algorithms for decades now, and while there has been some success, large areas of the US Gulf of Mexico have remained intractable. That's a prize of many billions of dollars to the US economy that we still cannot access.

It is well known that "the lower the frequency, the easier the problem becomes". Modeling indicates that with current algorithms, if we could record signals down to ~1.4 Hz at 30 km offsets, many existing model-building challenges should become algorithmically tractable. Unfortunately, the difficulty of making a seismic signal at a given acoustic power level scales with inverse frequency cubed. Thus, 1 Hz is not 10, but 1000 times more difficult to make than 10 Hz. Worse, the Earth itself rapidly becomes noisier below a few Hz. Combining these two effects, we find that as we attempt to obtain data below about 4 Hz, our signal-to-noise rapidly decreases. For the most part, the industry has put their efforts into an algorithmic solution to the problem, on the assumption that producing and operating a device capable of making usable signal-to-noise below 2 Hz would just be too difficult.

Needing a solution to this problem, and seeing that nobody else was investigating the "brute-force solution", in late 2006 we started investigating what it would take. As it turned out, the physical challenges could be overcome. In fact, they were not even the biggest challenges. The real challenge was overcoming our implicit assumption that low-frequency acquisition should look the same as conventional acquisition. Once we realized that we just need the low frequencies to create improved Earth models, not to image, the problem suddenly became a lot more tractable.

There are two morals to this story.
1) Sometimes it's easier to go get the data your existing algorithms need, than it is to keep trying to find an algorithm that works with the data you've got.
2) When you are doing something new, beware implicit assumptions!