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The Operational Efficiency of ISSN™ in Western Canada

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Summary

The use of single-vibrator, single-sweep, simultaneous sweeping techniques (SVSS) can result in a significant increase in crew productivity when compared to conventional, or traditional, 3D Vibroseis methods such as multi-vibrator, multi-sweep, “flip-flop” acquisition. In addition, the SVSS techniques can deliver, in a cost-effective manner, the high pre-stack trace density and the field trace data quality that are necessary to improve both the reliability and the fidelity of the final 3D seismic volumes (Ourabah, 2015). This paper summarizes Explor’s experience of applying SVSS techniques and documents the 10-fold increase in vibrator productivity that has been achieved by using BP’s ISSN™ technique in Western Canada.

Introduction

Since the early 1980’s the seismic industry has developed various “simultaneous source” Vibroseis techniques whose objective was to increase the seismic crew’s productivity without impacting the recorded data quality (Gartotta,1983). These early efforts were not always successful (Martin, 1993), but the introduction of slip-sweep in the late 1990’s (Rozemond, 1996) lead to the development of Distance Separated Simultaneous Sweeping (DS3 - Bouska, 2008) and Independent Simultaneous Sweeping (ISSN™ - Howe, 2008). Both DS3 and ISSN™ have delivered consistently high quality 3D volumes across a wide range of operating environments. Explor has operated several surveys in Western Canada using both slip-sweep and ISSN™ and has previously presented some of the results from those projects (Thacker, 2017). This paper focuses on the operational aspects of the ISSN™ projects with a view towards an improved implementation in future Western Canadian surveys.

The relative efficiencies of five different 3D Vibroseis operations in Western Canada are compared in Figures 1, 2 and 3 with some of the key metrics from these projects shown in Table 1. These five projects were acquired over the last few years, with the conventional “flip-flop” survey being acquired in 2012. All five surveys were performed on a 24 hour operating basis.

Obviously, there are many inter-related parameters that can affect the overall average daily production of a 3D Vibroseis crew, such as sweep length, the distance between adjacent VP’s, the roughness of the terrain and the number of vibrators per fleet, to name just four. For example, survey “ISSN-1” was acquired in rugged, forested, terrain that previously had been thought of as being a “drill-only” source area. The other four projects were acquired in a mixture of relatively flat farmland or prairie with isolated woodland areas and occasional water courses, and so are directly comparable.

The five projects used sweep lengths of either 16 or 20 seconds, with four of them using the same sweep length. Therefore, sweep length is not believed to be a significant factor in comparing the relative efficiency of the three different methods. In all five surveys, the sweep effort consisted of a single sweep at the VP location.

Results

There are several metrics that can be used to evaluate the operational effectiveness of the different sweeping techniques. We first looked at the average crew production levels for the five surveys (Figure 1) in terms of the number of VP's acquired per day and the resultant square kilometers covered per day. The four SVSS surveys out-perform the Flip-Flop survey in both of these metrics, but in terms of the average daily surface coverage achieved the Slip-Sweep survey appears to be very competitive compared to the three ISSN™ surveys. However, as shown in Table 1, the Slip-Sweep survey has a substantially lower VP density than do the three ISSN™ surveys, so this metric is likely misleading.

We next normalized the average crew production rates shown in Figure 1 by dividing these data by the number of active vibrators working on the crew (Figure 2). This graph of the average daily productivity per vibrator shows a clear trend in terms of the number of VP's acquired per vibrator per day. The ISSN™ surveys appear to show an improvement in productivity as increased operational experience is gained. However, as with Figure 1, Figure 2 appears to show that the Slip-Sweep survey was efficient in terms of the surface coverage.

Finally, we calculated the average time per day that a single vibrator spent creating useful seismic data. That is, we took the average number of VP's acquired per vibrator per day, and multiplied this by the sweep length plus the output record length. This "Sweeping Time" excludes all of the time spent moving up between VP's, the time invested in daily vibrator maintenance and QC, and the time lost during shift changes. The result is shown in Figure 3, which clearly shows the approximately 10-fold improvement in vibrator productivity of surveys ISSN-2 and ISSN-3 compared to the Flip-Flop survey. It also shows that the Slip-Sweep survey achieved substantially lower vibrator productivity than that achieved in any of the three ISSN™ surveys. If the ISSN™ technique had been applied to the Slip-Sweep project, then we would expect a substantial reduction in the overall survey duration with no impact on the final data quality.

Acknowledgements

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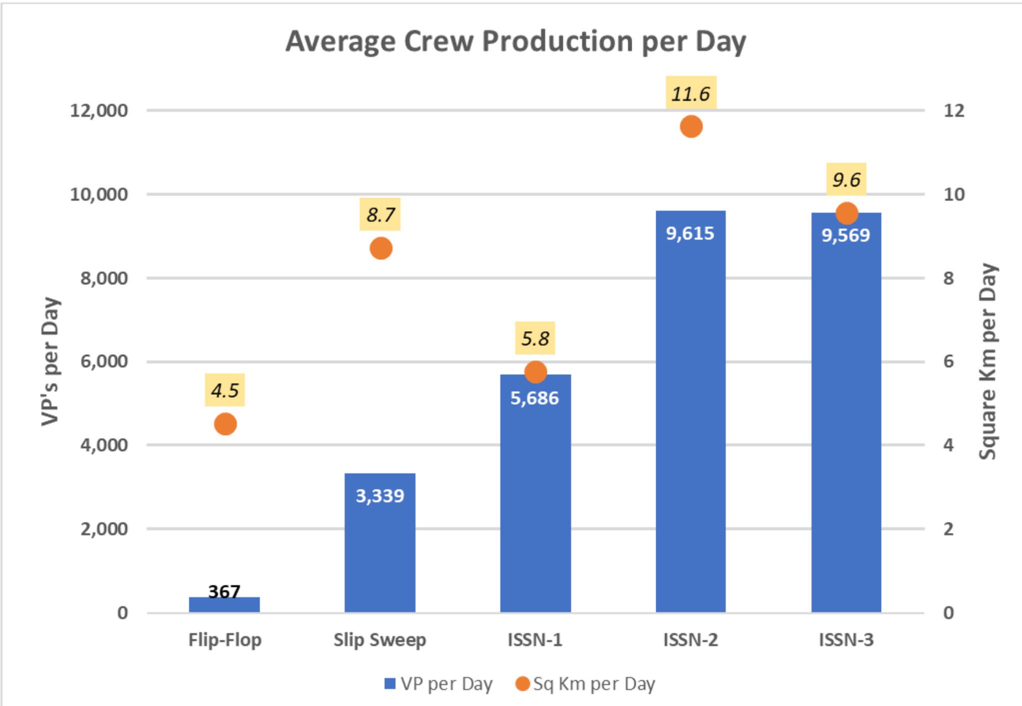

Figure 1

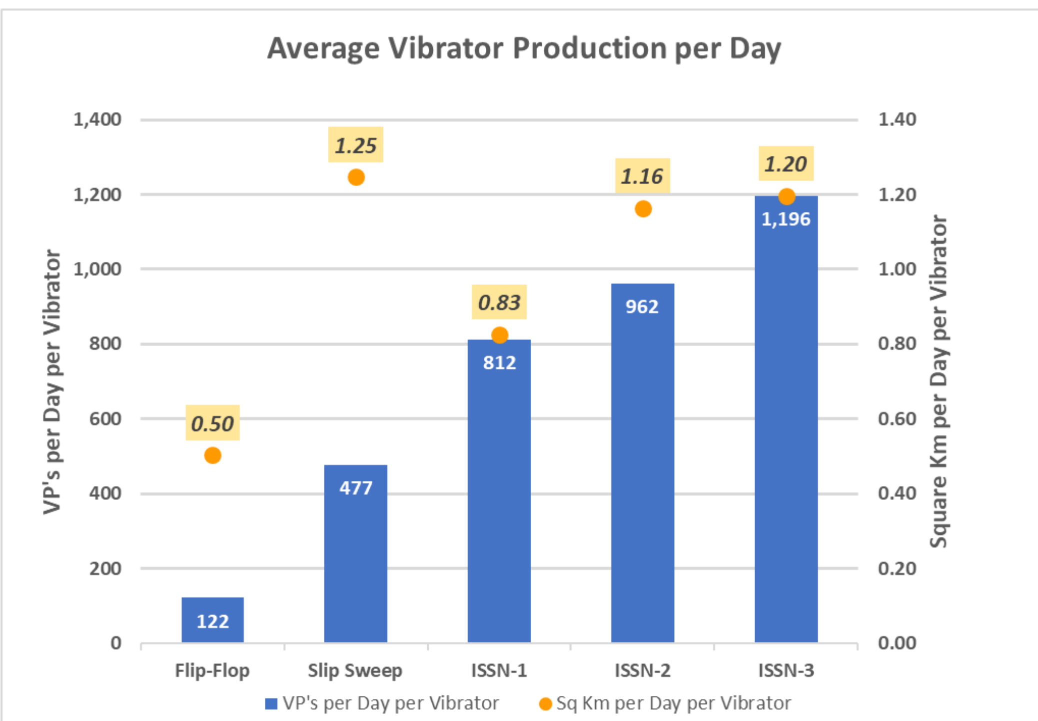

Figure 2

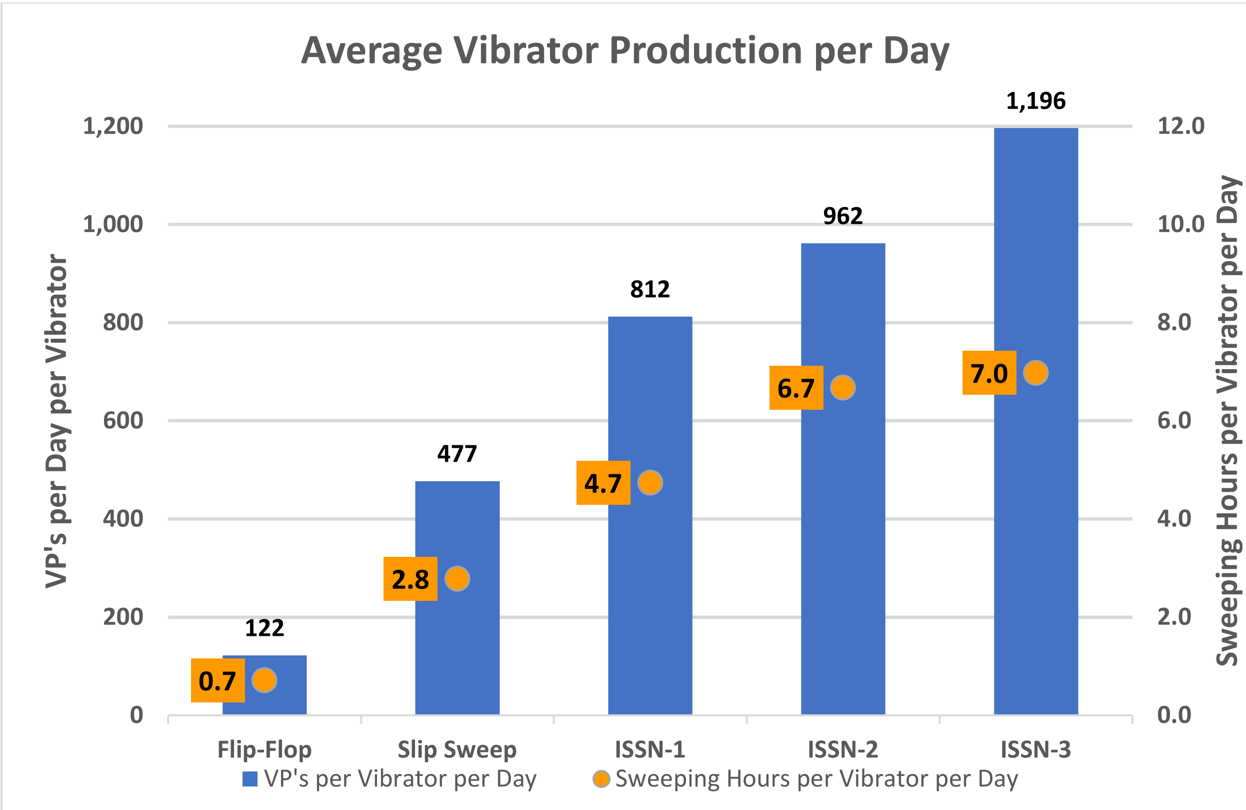

Figure 3

Table 1

	Survey Design Metrics				Survey Productivity Metrics		
Survey Name	Active Vibrators	Vibrators per Fleet	VP's per Square Km	Maximum Pre-Stack Trace Density	Average VP's per Day	Total Crew Sweeping Hours per Day	Sweeping Hours per Vibrator per Day
Flip-Flop	9	3	81	250,000	367	2.1	0.7
Slip-Sweep	7	1	383	2,400,000	3,339	19.5	2.8
ISSN-1	7	1	984	4,800,000	5,686	33.2	4.7
ISSN-2	10	1	826	4,600,000	9,615	66.8	6.7
ISSN-3	8	1	1000	7,000,000	9,569	55.8	7.0