Stereo satellite elevation mapping for stakeless 3D seismic surveying. Demonstration Project BP Libya

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PhotoSat
50cm resolution stereo WorldView-2 satellite photo
220 km²
Three ground survey points were used to reference the stereo satellite elevation mapping.
1.2m x 2.4m white painted steel sheets were used as ground survey targets.
Three ground survey points were used to reference the stereo satellite elevation mapping.
Three key technical components enabling high accuracy, high resolution elevation mapping from space

High resolution stereo satellite photos provide 50cm ground resolution

Adaptation of seismic processing systems for stereo satellite elevation processing

Graphics Processing Units (GPUs) make the elevation processing times cost effective

Three key technical components
enabling high accuracy, high resolution elevation mapping from space

High resolution stereo satellite photos provide 50cm ground resolution

Adaptation of seismic processing systems for stereo satellite elevation processing

Graphics Processing Units (GPUs) make the elevation processing times cost effective
1m posted elevation model derived from the stereo WorldView-2 satellite photos, 220 km².
1m contours created from the stereo WorldView-2 satellite elevation mapping.
Slope image derived from the stereo WorldView-2 satellite photos, 220 km². Red areas are steep slopes.
Slope direction image derived from the stereo WorldView-2 satellite photos, 220 km².
Shotpoints on 50m grid, except on steep slopes
Receiver points on 50m by 450m grid
Shotpoints on 50m grid, except on steep slopes
Receiver points on 50m by 450m grid
Seismic receivers were Geospace Seismic Recorders. These seismic receivers include GPS antennas. They record their locations to within about 2m in X and Y and 3m in elevation.
Receiver points were surveyed with a backpack GPS
Receiver points were surveyed with a backpack GPS
Seismic sources were vibroseis trucks
Seismic source locations were surveyed with GPS antennas mounted on the vibroseis trucks.
8,516 seismic receiver locations.
Seismic receiver locations

Elevation differences between the backpack GPS survey and the stereo satellite elevation mapping
Elevation differences between the backpack GPS survey and the stereo satellite elevation mapping

- Standard deviation: 33 cm
- Median: -14 cm

8516 receivers
70,423 seismic source locations.
Seismic source locations

Elevation differences between the vibroseis truck GPS and the stereo satellite elevation mapping
Seismic source locations

Elevation differences between the vibroseis truck GPS and the stereo satellite elevation mapping

70,423 sources

Standard deviation 30cm
Median -35cm
Advantages

Advanced scouting reduced by ~ 80%

Current practice is for field survey crews to scout all vibrator points and access routes in advance to identify inaccessible source-points and to plan for efficient disposition of the vibrator trucks.

The satellite imagery with this DEM gives an accurate enough picture so that only a few areas require field visits in advance.
Benefits

Quality Control of Source Positioning

All source-points are surveyed using the GPS systems mounted on the vibrator trucks.

Initialisation time for these systems can be long, with up to 30 minutes before we have full confidence in the elevation accuracy after switch on.

Elevation accuracy can also suffer due to poor satellite visibility on occasions.

Comparison with the DEM highlights any problem areas.

The DEM can be used where the vibrator GPS elevation is obviously in error.
Receiver Positioning

Thousands of recording nodes are deployed for the 3D seismic survey.

Non-augmented GPS receivers in each recorder give sufficient x, y accuracy but cannot provide sufficiently accurate elevations in stand-alone mode for seismic processing requirements.

The stereo satellite DEM provides the necessary receiver location elevation accuracy for seismic processing and so removes the need for any additional surveying of receiver locations.
Next steps

4,000 km$^2$ mapping area

Full scale operational test of stereo satellite elevation mapping for a large 3D seismic survey.

Stereo satellite photos currently being acquired.