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HIGH RESOLUTION DATA ACQUISITION SYSTEM UPDATE

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SUMMARY

Last year I reported the development of a new data acquisition system for recording high frequency cross-well seismic data. The system includes a downhole source and hydrophone array operating in the band of 200-4000 Hz, and two fully equipped logging trucks for crosswell operations. The source was built by Southwest Research Institute and the hydrophone array by Century Geophysical Corporation. The logging trucks are being reconditioned and will be ready for field operations by the end of summer. Over the past year, four cross-well surveys (at Gulf Coast and West Texas sites) and a deep hole transmission test (Gronigen, N. Holland) were successfully run with STP's new high resolution cross-well data acquisition system. This short paper reviews the general system, describes recent additions to the hardware, and provides a brief summary of planned future improvements.

SYSTEM DESCRIPTION

A schematic description of the source system is given in Figure 1. The original source has two active ceramic elements, symmetrically balanced between two high power step-up transformers. These elements are wired to be driven either in phase or 180 degrees out to create a single extended monopole or a vertical dipole source. The new source unit has three active ceramic elements configured into a three-element adjacent array for purposes of beam-steering. Each element is independently driven as illustrated in Figure 1. When beam steering is not desired, the elements may be operated as three independent sources to speed data acquisition. Source signatures are generated by three 12-bit D-to-A phase-coherent waveform generators. Arbitrary programmable waveforms including sweeps, pulses, and pulse sequences can be generated.

The source is powered by a three-channel 24 kVA linear power amplifier built to STP's specs by Instruments, Inc. This power is delivered via a 7-conductor armored wireline designed at STP and built by the Rochester Corporation. The cable maintains the standard 7-conductor configuration but utilizes larger low resistance conductors and special insulation for more efficient power transfer to the source. Downhole step-up transformers at the source are optimized for the three-element and special cable operation.

A block diagram of the receiver system is shown in Figure 2. The system consists of a 9-element hydrophone array. Two Compu-Log computers (one in the source truck and one in the receiver truck) provide joint control and monitoring of the receiver system and to a limited degree the source as well. The system operator has complete software control over system configuration, including selection of the source signature, receiver sampling rates, analog and digital gains, stacking depth, and filter settings. The computers also monitor sonde depth and provide display of user selected recorded data traces. Data are recorded to hard disk and written to tape in SEGY format.

The receiving system uses OAS deep ocean hydrophones as detectors. Each hydrophone is housed in a slotted stainless steel enclosure interconnected with 7-conductor logging cable and has a dedicated DSP for 16-bit downhole digitization. Shots may be stacked downhole to recorded lengths of 16,000 samples at a sample rates down to 50 υSec. Current filter settings include a 250 and 350 Hz lo-cut and 2000 Hz and 4000 Hz hi-cut. Data are telemetered to the surface at a maximum rate of 38,400 baud. Increased data rate options are scheduled for upgrade following this years' acquisition season. A more detailed block diagram of the Compu-log system is given in Figure 3.

The receiver sondes and interconnect cableheads have been successfully tested to temperatures of 125 Centigrade and pressures to 5000 psi. Each receiver sonde is 2 1/2 inches in diameter and about 4.5 feet long each.

PLANNED HARDWARE UPGRADES

There are several changes to the overall system either complete or in progress. These are (1) the addition of the third source transducer element and 3-channel driver for testing source beam steering; (2) the addition of two wireline trucks - one with a special high power source cable; (3) the addition of an analog channel to the receiving array; (4) the addition of a gamma ray logging tool; (5) and, reconfiguration of the source and receiver for operation in the same borehole. A much needed three-axis detector is not yet available.

A special analog receiving channel is being installed on the Compu-Log downhole digital system. This channel is to be used for in-filed monitoring and quality control.

Also, new lo-cut and high-cut filter cards are available and will be added on an as-needed basis.

Schlumberger Well Services has donated two tandem-axle logging trucks to STP. These trucks are being reconditioned and retro-fitted with measuring heads, etc and made ready for field operations. The source truck will have 11,000 feet of high power 7-conductor cable (0.569") installed. The receiver truck will have 17,000 feet of 7-conductor cable (0.46").

A gamma ray logging tool will be added to the system as an aid for depth control and tie to other wireline logs. Initially, the gamma logging will not be fully integrated onto the crosswell system but must run separately. We expect to upgrade this to a fully integrated system next year.

The source and receiver array are being reconfigured for operation in the same borehole as a seismic logging or single-well reflection profiling system. This appears not to be too difficult because the receiver system uses only four conductors and the source only two out the 7-conductor cable. One identifiable need is for source-receiver tube wave isolation.

Finally, we are planning to install one of STP's DEC 5000 workstations in the logging trucks during field operations. This system will run all the tomography software and possibly ProMax (if a license can be obtained). Options include a high resolution plotter and a 1/2" tape drive.

ACKNOWLEDGEMENTS

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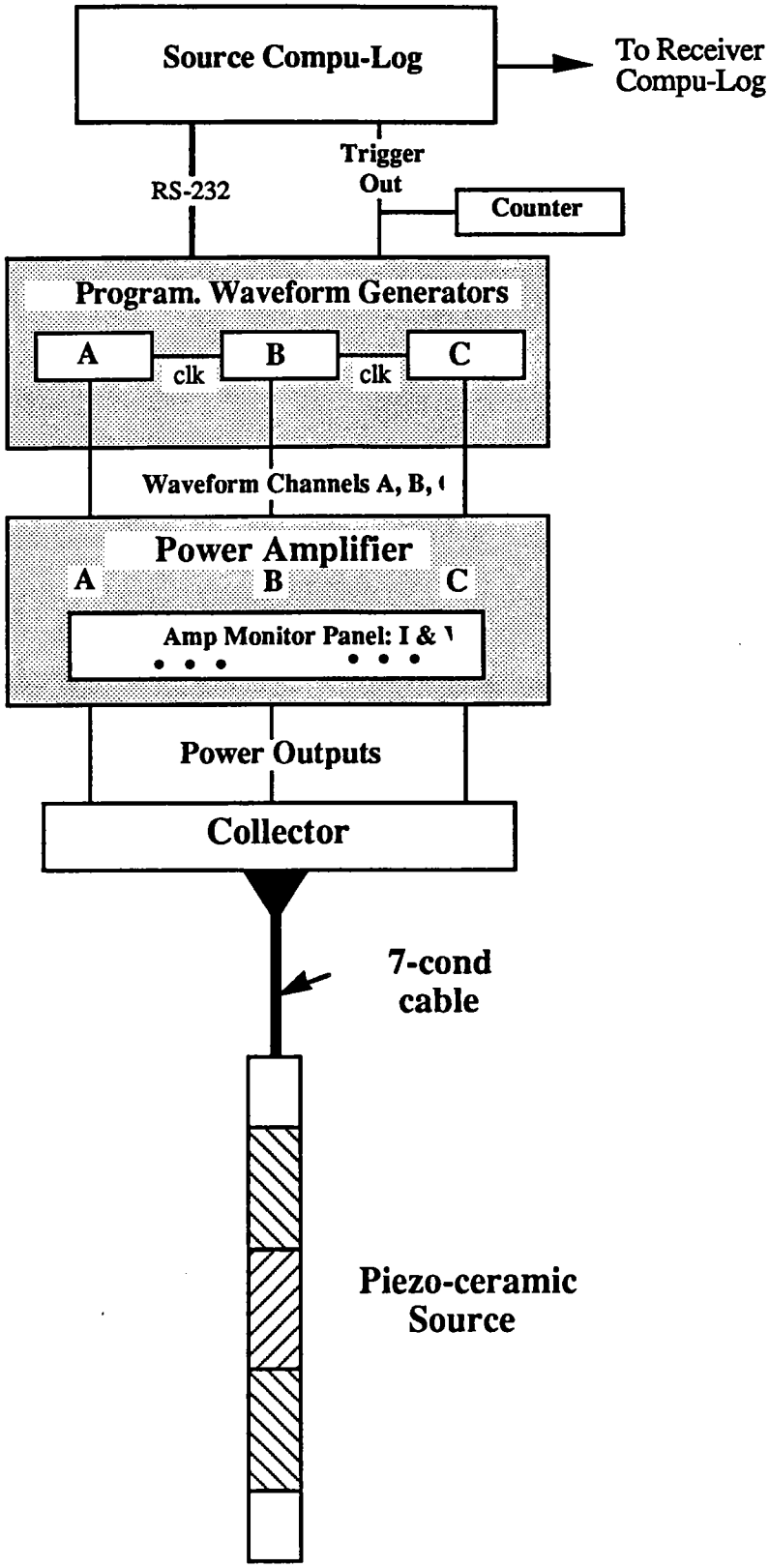

Figure 1. Piezo-ceramic downhole source and driver system.

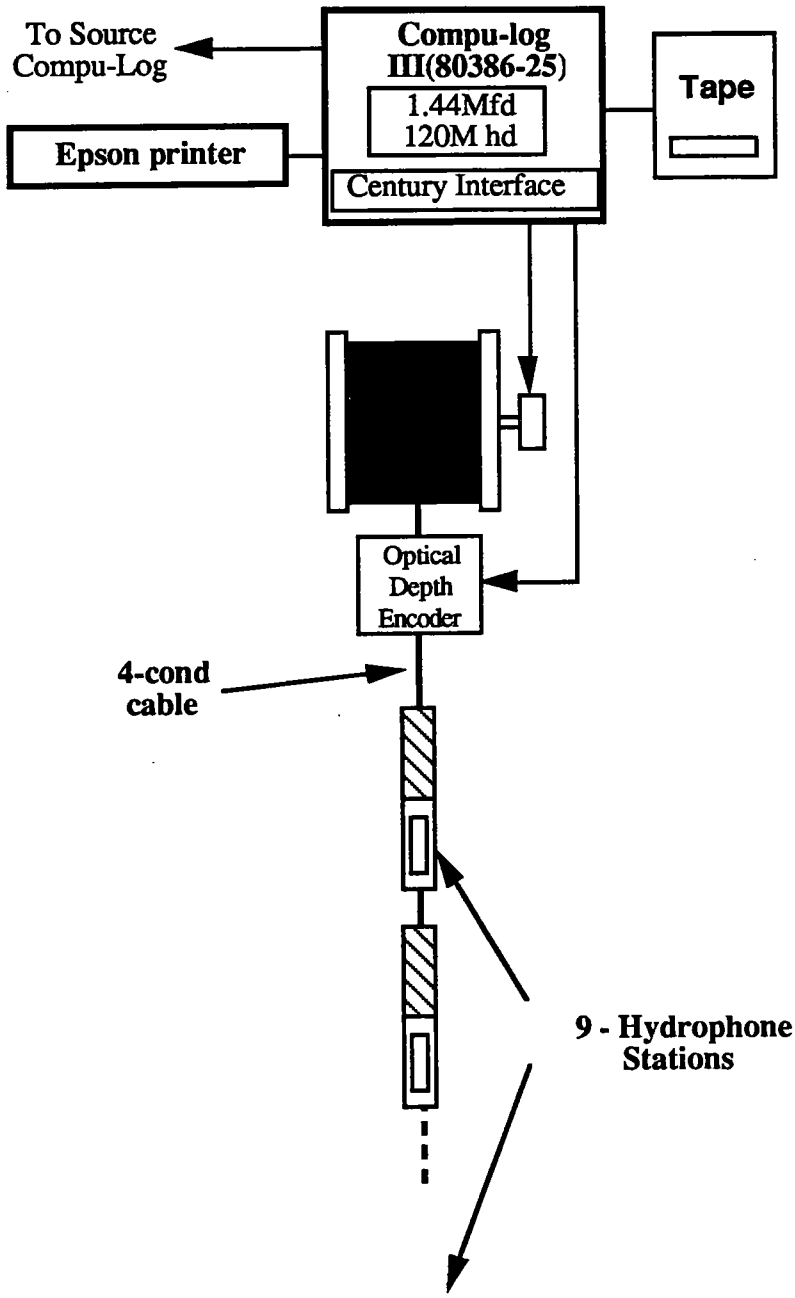

Figure 2. Nine-element hydrophone array system.

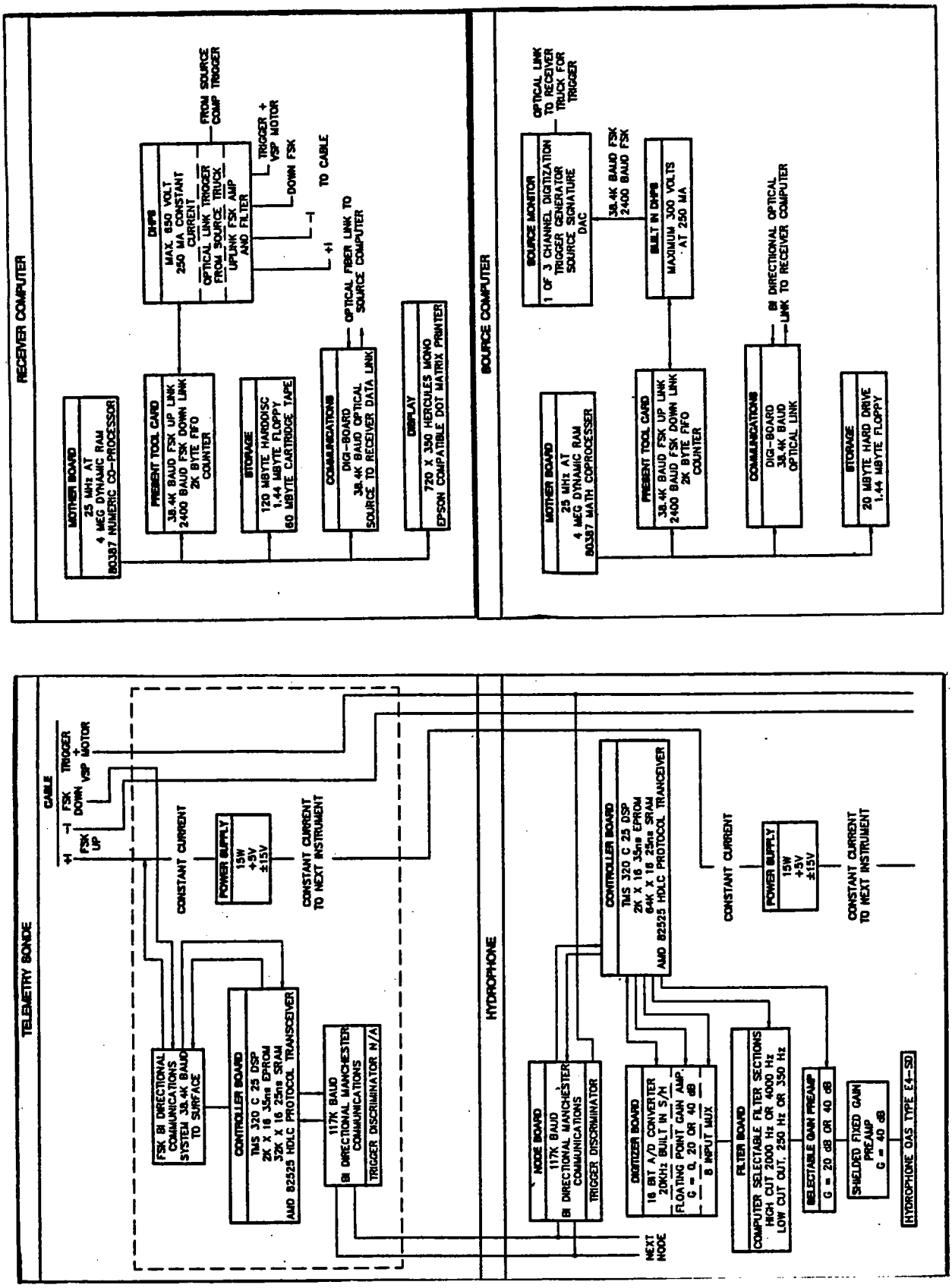

Figure 3. Detailed block diagram of the Compu-log receiving system.