Interactive identification of water-bottom multiples

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ABSTRACT

Continuation of a reflection event through a water layer is approximated by updating the parameters — zero-offset traveltime and root-mean-square velocity — of a hyperbolic traveltime curve. The continuation process depends on a single parameter, the traveltime through the water layer.

A scan over traveltimes through the water-layer is readily generated in an interactive computer program by moving the mouse up or down. To identify water-bottom multiples interactively, the operator chooses first a primary event and a traveltime through the water layer and then compares an overlay pattern of multiple reflections to the data.

Approximate continuation of multiples

Assuming hyperbolic traveltime curves, the following expressions can be written for the traveltime curves of two events, P and M:

$$t^2 = t_P + \frac{x^2}{v_P^2}, \tag{1}$$

and

$$t^2 = t_M + \frac{x^2}{v_M^2}, \tag{2}$$

where t is the traveltime measured at offset x; t_P and t_M are zero-offset traveltimes, and v_P and v_M are RMS velocities, respectively for the primary P and for the multiple M.

When the event M is a water-bottom multiple of the event P, the difference between the zero-offset traveltimes of the primary and of the multiple corresponds to a travelpath in the water layer, where the interval velocity v_W is known. The water velocity v_W can be either estimated from the slope of the direct arrival, or it can be approximated by $v_W = 1.5$km/sec.

Given the parameters t_P and v_P of the primary P, the water velocity v_W and the traveltime in the water layer δt, the RMS velocity of the multiple can be found from the following relations,

$$\delta t = t_M - t_P \tag{3}$$
$$t_M {v_M}^2 = t_p {v_P}^2 + \delta t {v_W}^2.$$

which is valid both for positive and negative δt. Thus for a fixed primary event P, the velocity of the multiple v_M is a function of only one parameter — the difference in traveltimes δ_t.

An interactive program

An interactive program implements the continuation procedure described above. Figures 1,2 and 3 illustrate the use of the program and the interactive identification of a series of 6 water-bottom multiples on a marine shot profile (#27, Yilmaz and Cuomro, 1983).

ACKNOWLEDGMENTS

I would like to thank Jon Claerbout for suggesting this interactive process to me. Thanks to him and to Rick Ottolini for help in the writing of the program.

REFERENCES

Yilmaz, O., and Cuomro, D., 1983, Worldwide Assortment of Field Seismic Records, released by Western Geophysical Company of America, Houston.

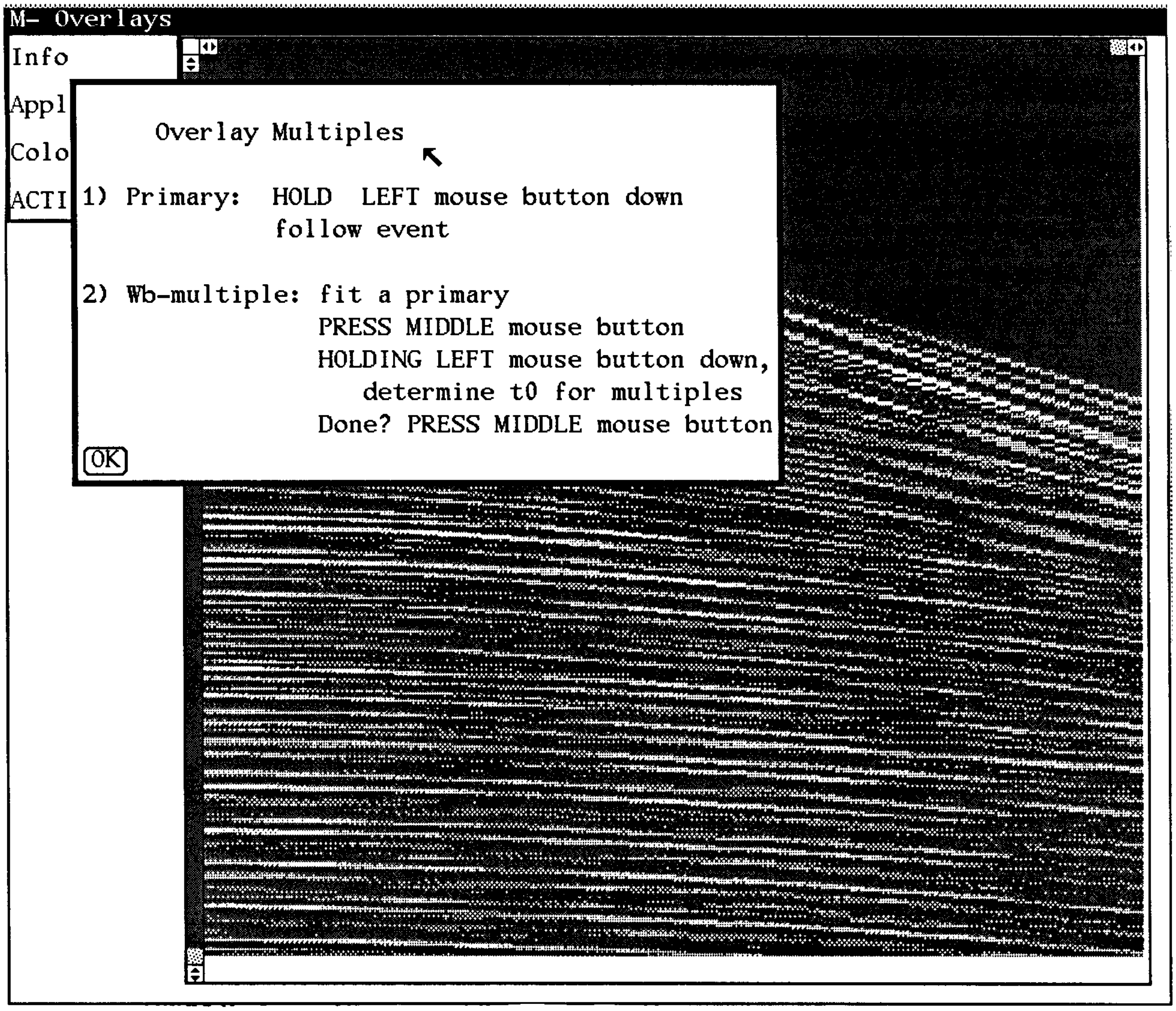


FIG. 1. Example of documentation: a window labeled "Overlay multiples" contains the instructions for generating overlay patterns for the primary and for the multiple events.

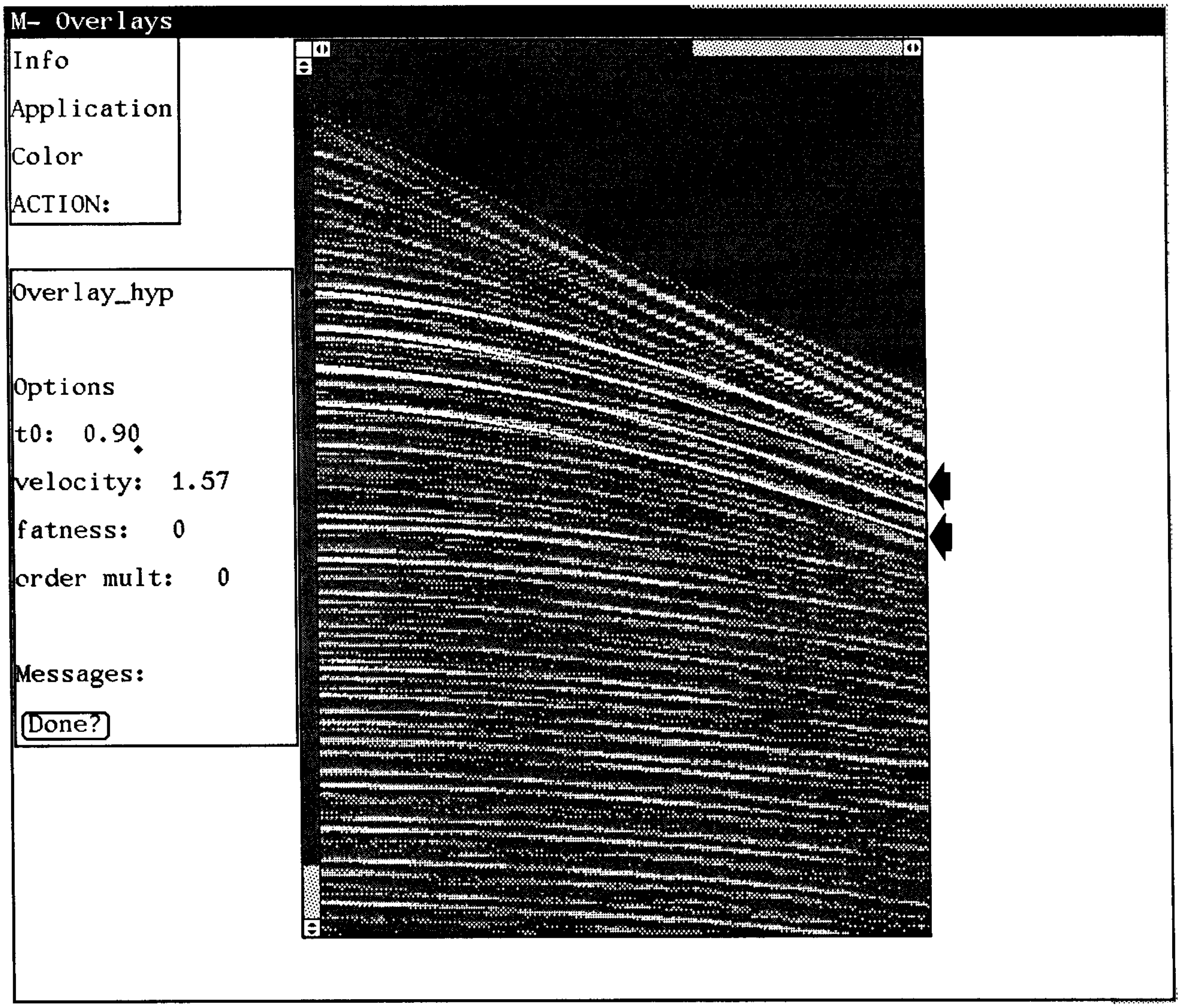


FIG. 2. A primary reflection is selected first (black arrow in the scrollbar near zero-offset) and a series of three multiples is identified. Three white hyperbolas are superposed on the multiples; two black arrows point to the hyperbolas at far offset. The original events without overlays are visible on Figure 3.

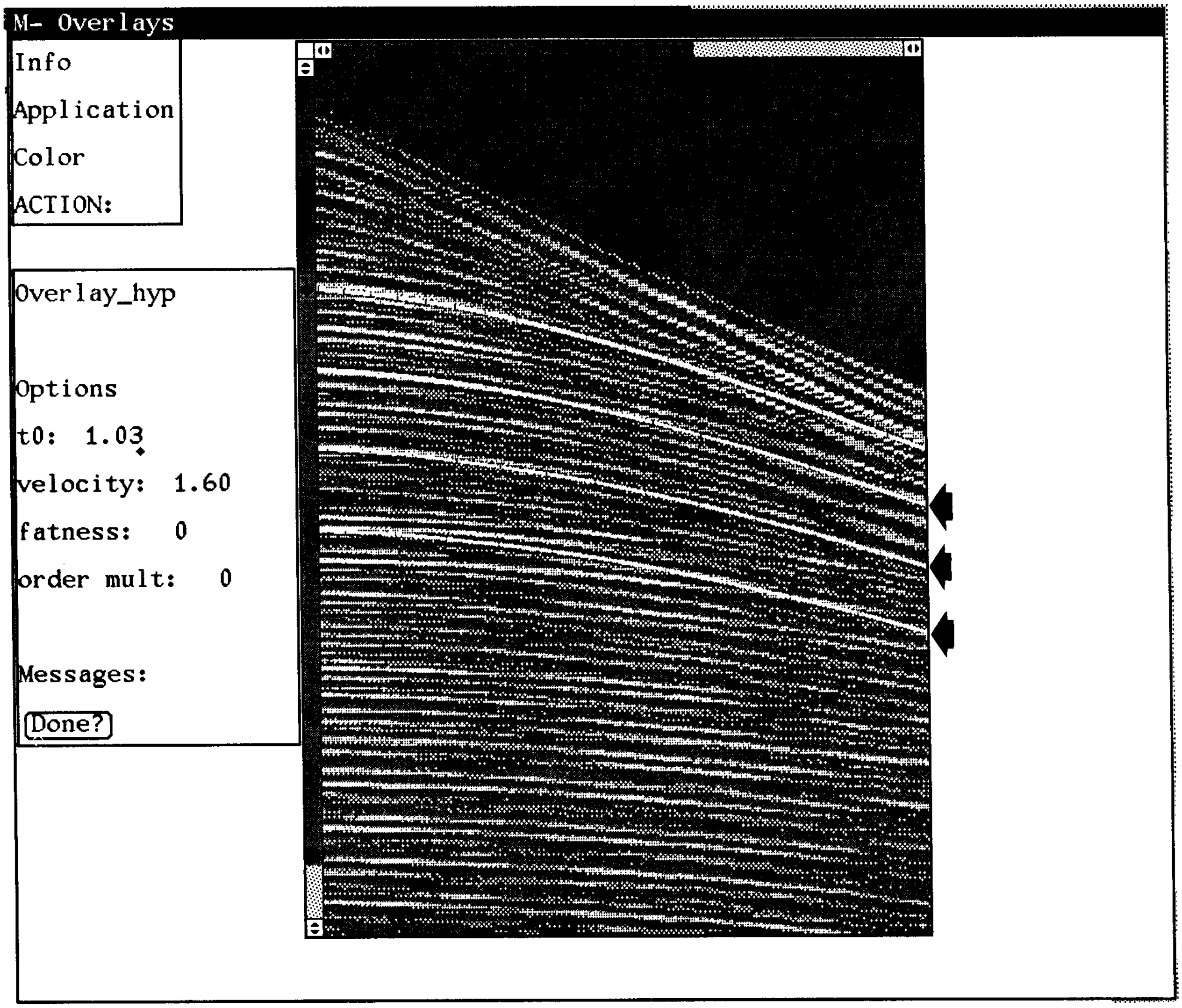
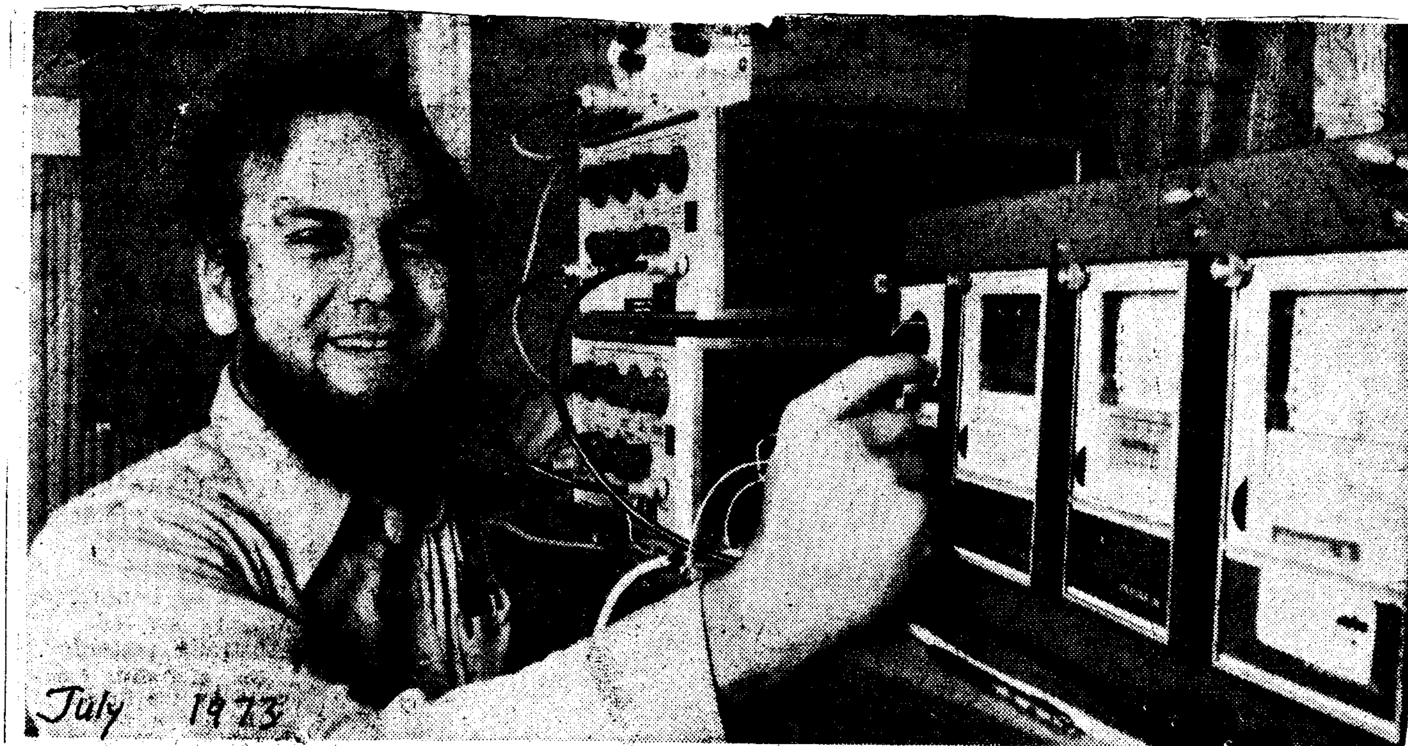


FIG. 3. A second series of three multiples, at twice the period of a water-bottom bounce, is selected. The primary is marked with a black arrow near zero-offset, while the white hyperbolas superposed on the multiples are marked with black arrows at far offsets. The multiple events without overlays can be seen in Figure 2.



July 1973

PROFESSOR Claerbout with his microbarograph yesterday: "a detached doom-watcher."

Nuclear 'doomwatch' from a Sydney flat

By GRAHAM WILLIAMS

AN AMERICAN scientist will monitor the French nuclear blast with a rare device mounted on a wardrobe in his Sydney flat.

Professor Jon Claerbout, who brought the device with him from the U.S. recently, describes himself as "a detached doomwatcher."

The device, a microbarograph which records very low changes in air pressure, will be probably the only instrument in Australia to record the atmospheric explosion.

But as airwaves from the blast will travel at about 300 metres a second — about the speed of sound — they will take five or six hours to reach Australia.

Professor Claerbout, associate professor of geophysics at Stanford University, has previously detected one "and possibly two" Chinese nuclear tests with the instrument.

A GOOD CHANCE

But he warns, that, although the instrument is highly sensitive to the long-distance, high-altitude airwaves, it will not record a small blast.

"We tried to record the last French tests at Mururoa Atoll from Stanford — but they were too small to record," he said.

"As Stanford is about the same distance from Mururoa as Sydney, we can expect to record the blast only if it is larger than the previous bomb.

"But if they let it off on a nice quiet day without any wind, there's a good chance we'll pick it up."

Professor Claerbout says his machine is one of only about 12 in the world — most of them in the U.S.

He is here lecturing at Macquarie University until August.

The professor, who monitors nuclear tests as a part-time interest, brought the machine with him because he though Australia was closer to Mururoa than Stanford, and he would have a better chance of detecting the blasts.