STABILITY AND VARIABLE VELOCITY MIGRATION: AN UPDATE FOR PROGRAMS IN SEP-15

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In SEP-15 (pp. 1-20), I described an algorithm for extrapolation of wavefields through media with laterally variable velocities. After migration programs using this algorithm had been in use for several weeks (see Bloxsom and Ottolini, SEP-15, pp. 251-272), it was discovered that migrations of random noise with large velocity contrasts on nearly vertical interfaces sometimes resulted in instabilities (Bloxsom and Kjartansson, SEP-15, pp. 21-38). The conditions resulting in instabilities were rather irrelevant with respect to applications in reflection seismology since instabilities only occurred for nearly vertical interfaces (in which case the exploding reflector model is invalid - see Kjartansson and Rocca, this report) and for frequencies very near dc. Consequently, this caused no great concern among the more data-oriented SEP members, and the unstable algorithm has been in continuous use (e.g. Bloxsom Lynn et al, this report). The more theoretically inclined were more interested. Jon Claerbout, Francis Muir, Bert Jacobs and Bob Godfrey all contributed to the solution of this problem (this report: Godfrey et al, p. 83 ; Godfrey and Jacobs, p. 97 ; and Jacobs et al, p. 89). It turns out that the change required to make the programs I gave in SEP-15 stable is almost trivial, and the discretization used is the same as given by Equation (3) in Jacobs et al, with the exception that the tridiagonal matrices are transposed. Figure 1 shows the changes (underlined) required to make DDIFF and DDMIG (SEP-15, pp. 13-16) stable. Figure 2 shows examples of outputs of DDMIG before and after the changes.

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c
c           Einar Kjartansson, September 1978.
c
c        Bullet proof version, E.K. april 1979.
c
         complex wave(64,64),t(64),d(64),a(64),b(64),e(64),f(64)
         complex aa(64),bb(64),ref(64)
         complex  cexp,cmplx
         complex shift,cc3,cc1,rr3,rr1,bab,ra,dipflt
         complex abp(64),cbp(64)
         equivalence (a(2),abp(1)) , (a(1),cbp(2))
         real m,vel(64)
c
c        Read in parameters and set constants
         :
         :
c
c        Solve Crank-Nicolson matrix equation
c
         d(1) = bb(1)*t(1) + aa(2)*t(2)
         d(nx) = bb(nx)*t(nx) + aa(nx-1)*t(nx-1)
         do 70 ix = 2, nx-1
70          d(ix) = bb(ix)*t(ix) + aa(ix-1)*t(ix-1) + aa(ix+1)*t(ix+1)
         call cvtri(abp,b,cbp,nx,t,d,e,f)
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FIGURE 1.--A listing of the changes needed to make DDMIG (SEP-15, pp. 15-16) stable. *Changes are underlined.* Same changes will make DDIFF (SEP-15, pp. 13-14) stable.

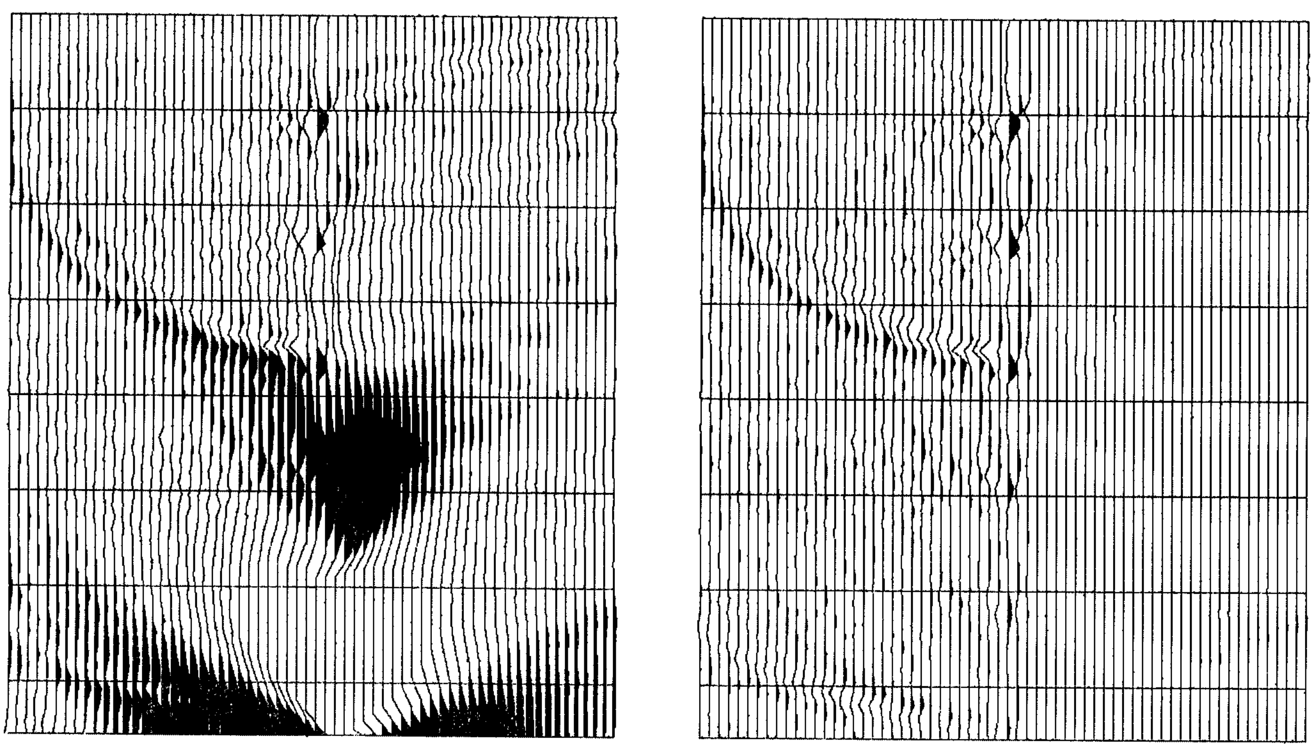

FIGURE 2.--Output of DDMIG before (left) and after (right) the changes in the discretization. Migration of an impulse in time and space, with a vertical discontinuity three traces to the right of the excitation. The velocity on the right is twice that on the left. The number of frequencies and z-steps used is 64.