SOME RECENT EXTENSIONS OF THE REFLECTIVITY METHOD

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Abstract. Different aspects of the reflectivity method are illustrated for the case of SH-wave propagation in a layered half-space. Starting with the original form of the reflectivity method, the combination with generalized ray theory is described which allows calculations of many interesting seismic phases, such as surface reflections and surface multiples, for only little additional computing time. Then the calculation of complete seismograms is described, first with wave-number integrals whose integrands have little or nothing to do with reflectivities, and second with integrands consisting mainly of the reflectivities of different parts of the layered medium. Each case is illustrated with an example of theoretical seismograms. Finally, a few remarks are made on aliasing in the time domain, on fast Hankel transforms and on causal absorption with frequency-dependent Q-factor.

INTRODUCTION

Since the original development of the reflectivity method...
method by Fuchs (1968) this method for theoretical seismograms has undergone several modifications. It is the purpose of this report to describe some of these. Concentration naturally is on extensions that have been developed mainly at the Geophysical Institute at Karlsruhe; the reflectivity method, however, is in widespread use and thus has seen other modifications which will not be covered in the following.

The extensions which are discussed here can be divided into two groups. The first group includes combinations of the reflectivity method in its basic form (i.e. for a homogeneous half-space on top of a layered reflecting half-space) with generalized ray theory in order to allow for modifications of the incident and/or reflected wave field by a layered medium on top of the reflecting half-space. The principle of such combinations has been described some time ago by Fuchs and Müller (1971). It has recently been applied by Schott (1979) in the SH-wave case to the mantle S wave, the surface reflection sS and the free-surface multiples of the wavesystem S+sS, and by Faber and Müller (1980) to the corresponding P waves (including sP) and to conversions from S to P and from P to S at discontinuities above the reflecting half-space. In all these cases the basic feature of the original version of the reflectivity method, namely calculation of reflectivities or plane-wave reflection coefficients, is preserved. The theoretical seismograms are not complete seismograms, but display only those body-wave types which one wants to calculate.

The second group of extensions of the reflectivity method has the more ambitious aim of calculating complete seismograms. In principle the problem has been solved analytically some time ago in connection with surface-wave studies (e.g. Harkrider 1964), but only recently Kind (1978) calculated complete seismograms numerically along these lines. The integrands in the corresponding wavenumber integrals in this case include all wave types of the medium, not only the body waves, and thus are not reflectivities. Kennett and Kerry (1979) have shown, however, that the integrands can be expressed by reflectivities of different sections of the layered medium; Kennett (1980) has calculated theoretical seismograms with this method.

Since the purpose of this presentation is mainly tutorial, these extensions will be described in some detail for the simple case of SH-wave propagation. The