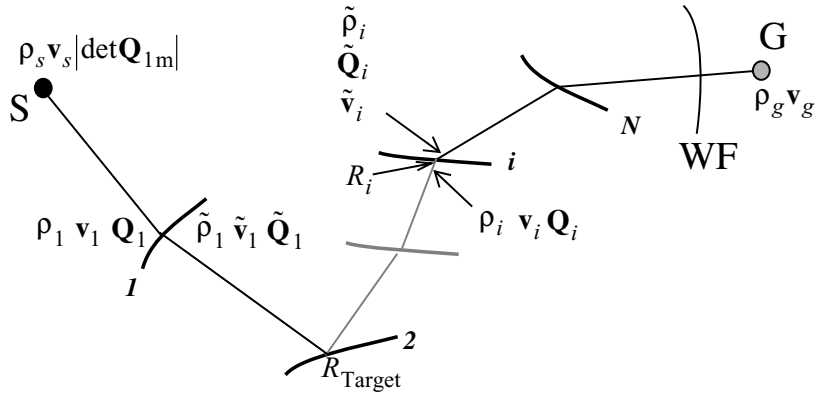

FIGURE 1. A typical ray starting at source S and ending at geophone G, which is reflected at the target interface number 2. The ray is transmitted through several other interfaces.

AMPLITUDES IN NORSAR 3-D V3.0.2P (PATCHES 1-6)

In NORSAR 3-D V3.0.2p, the complex-valued amplitude is defined in the following way:

$$U = U_{1m}\sqrt{\rho_s v_s \left|\det Q_{1m}\right|} \times \sqrt{\frac{1}{\rho_r v_r \left|\det Q_r\right|}} \times \prod_{i=1}^{n} R_i \sqrt{\frac{\widetilde{\rho}_i \widetilde{v}_i \left|\det \widetilde{Q}_i\right|}{\rho_i v_i \left|\det Q_i\right|}} \times e^{-\mathrm{i}\frac{\pi}{2}k} \times e^{-\pi f t^*},$$

where $U_{1m} = 1$, $|\det Q_{1m}| = (v_s \times 0.001\text{km})^2$, (ρ_s, v_s) are density and velocity (P or S) at the source, (ρ_r, v_r, Q_r) are density, velocity (P or S), and spreading matrix at the receiver, k is the KMAH index, t^* is the anelasticity factor, and R_i is the displacement transmission/reflection coefficient at interface i. The tilde marks values at the departing side of the interface, values without tilde are taken from at the incidence side (see also Figure 1).

For P waves the tracer calculates one amplitude value along the longitudinal direction. For S waves two amplitude values, each perpendicular to the longitudinal direction, are calculated.

The amplitude can be subdivided into the following factors, which depend on the medium between source and geophone position:

Geometrical Spreading. The scalar real-valued geometrical spreading (GS) factor (can be extracted in the *Event Attribute Extractor* (ES) - note that this value can be negative):

$$GS = \det Q_r.$$

Transmission / Reflection Coefficient. The scalar complex-valued total transmission / reflection (TR) loss factor(s) for n ray/horizon intersections (can not be extracted directly in the ES in NORSAR 3-D V3.0.2p):

$$TR = \prod_{i=1}^{n} R_i \sqrt{\frac{\widetilde{\rho}_i \widetilde{v}_i}{\rho_i v_i}}.$$

As for the amplitudes, the tracer calculates one value for P waves and two values for S waves.

Phase Shift due to Caustics. The scalar complex-valued phase shift is defined as

$$PHASE = e^{-\mathrm{i}\frac{\pi}{2}k}.$$

The KMAH index k can be extracted in the EA.

Anelasticity Factor. The scalar real-valued anelastic attenuation factor is defined as

$$t^* = \int_{\text{along ray}} \frac{1}{Q_{Anel}(T)} dT.$$

Q_{Anel} is the quality factor of the medium along the ray.

This factor can be extracted in the EA, but it can not be included in the amplitude of the EA module. But it is possible to apply it as additional factor to the amplitudes of the Seismogram Generator:

$$ATT = e^{-\pi f t^*}$$

with frequency f.

Selection in the Event Attribute Extractor / Seismogram Generator. With the tree (four) buttons in the *Event Attribute Extractor* (*Seismogram Generator*), the elastic amplitude(s) (or parts of it) can be extracted. For brevity, attenuation and KMAH effects have not been included in the following expressions:

GS **on**, TR **on**:

$$U = U_{1m} \sqrt{\rho_s v_s \left|\det Q_{1m}\right|} \times \sqrt{\frac{1}{\rho_r v_r \left|\det Q_r\right|}} \times \prod_{i=1}^{n} R_i \sqrt{\frac{\widetilde{\rho}_i \widetilde{v}_i \left|\det \widetilde{Q}_i\right|}{\rho_i v_i \left|\det Q_i\right|}},$$

GS **off**, TR **on**:

$$U = U_{1m} \sqrt{\rho_s v_s \left|\det Q_{1m}\right|} \times \sqrt{\frac{1}{\rho_r v_r}} \times \prod_{i=1}^{n} R_i \sqrt{\frac{\widetilde{\rho}_i \widetilde{v}_i \left|\det \widetilde{Q}_i\right|}{\rho_i v_i \left|\det Q_i\right|}},$$

GS **on**, TR **off**:

$$U = \sqrt{\frac{1}{\left|\det Q_r\right|}},$$

GS **off**, TR **off**:

$$U = U_{1m}.$$

Note that the button combination: TR **on**, KMAH **on**, and GS **off** *ONLY* works in the *Event Attribute Extractor,* if patch 06 for NORSAR 3-D has been applied!