Velocity-porosity relationships for cover sediments and accreted sediments from Nantro-SEIZE Stage 1, Sites C0001, C0002 and C0003

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We have examined velocity-porosity relationships for cover sediments, forearc basin sediments and accretionary prism sediments. Because porosity is the dominant control on velocity, empirical and theoretical relationships between compressional velocity and porosity have been examined in various tectonic. Through those efforts, it has been noted that the velocity in shallow, unconsolidated sediments depends on not only porosity, but also on lithology (e.g. shale/clay fraction) and consolidation history (e.g. cementation, deformation).

In NantroSEIZE Stage 1, cover sediments, forearc basin sediments and accreted sediments in the hanging wall of an out of sequence thrust were drilled at sites C0001, C0002, and C0004, for logging while drilling (LWD) in Expedition 314, and for coring in Expeditions 315 and 316. The logging data and core data provide a good opportunity to compare characteristic velocity-porosity relationships between those sediments. We have conducted ultrasonic velocity measurement tests to support the reliability of LWD data.

The focused areas in this study are sites C0001, C0002 and C0004. All sites are located in the hanging wall of an out-of sequence thrust. Site C0004 is located near the tip of the thrust. Site C0001 is situated ˜3.5 km landward of site C0004. Site C0002 is located further landward, ˜8 km from Site C0001. Cover sediments were obtained from C0001 Unit I, C0004 Unit I, Unit III and Unit IV. The C0004 Unit IV are footwall units overridden by the accreted sediments of C0004 Unit II on the basis of age. Forearc basin sediments were recovered from C0002 Unit II and Unit III. Accreted sediments were obtained from C0001 Unit II, C0002 Unit IV, and C0004 Unit II. C0004 unit II is slightly younger than other units of accreted sediments, indicating that C0004 unit II is also overridden by the other landward units.

Porosity is converted from bit resistivity in logging data using Archie's law because the porosity from bulk density can be overestimated due to the overestimation of water content within the smectite interlayer. The compressional wave velocity from laboratory tests basically represents a good agreement with LWD data except for the very shallow portion (up to ˜100m below sea floor) of the core. Porosity and velocity for cover sediments in C0001 Unit I and C0004 Unit I ranges from ˜0.8 to ˜0.6 and ˜1.6 km/s to ˜1.8 km/s, and for the forearc basin in site C0002, ranges from ˜0.45 to ˜0.35 and ˜1.7 km/s to ˜2.7 km/s. For cover sediments in C0004 Unit III, porosity and velocity are observed from ˜0.45 to 0.55 and ˜1.9 km/s to ˜2.4 km/s, respectively. In accreted sediments, porosity and velocity represent from ˜0.6 to ˜0.5, and ˜1.7km/s to ˜2.0 km/s for sites C0001 and C0004 and from ˜0.4 to ˜0.3 and ˜2.0 km/s to 3.5 km/s for site C0002.

The velocity-porosity relationship for accreted sediments shows relatively higher velocity than that of cover sediments and forearc basin sediments except for the relationship in deeper cover sediments observed in C0004 Unit III and Unit IV. While the velocity-porosity relationships for cover sediments and forearc basin sediments tend to follow the empirical relationship, the relationship for accreted sediments shows a higher slope than that predicted by the empirical relationship. The relationship for the deeper slope basin in C0004 Unit III and Unit IV seems to follow the trend observed in accreted sediments rather than that of cover sediments.

The differences in velocity-porosity relationships between cover sediments, forearc basin sediments and accreted sediments can be explained by differences in lithology or consolidation history. Because the sediments in C0004 Unit III and Unit IV are cover sediments overridden by accreted sediments and show a similar velocity-porosity relationship with that observed in accreted sediments, the consolidation history might be a major factor to explain the differences in the velocity-porosity relationships.