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Tectonic and Climatic Influences on Submarine Fan Development in the Niigata Backarc Inverted Rift Basin, Central Japan: Confined Turbidites Related to Basin Tectonics and Highstand Fan Sedimentation Related to Paleoceanography of the Japan Sea

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The Neogene Niigata-Shin'etsu basin in Northern Fossa Magna, located in a backarc setting of the Japan arc (Fig. 1), provides unique examples of tectonically and climatically controlled submarine fan sedimentation.

The basin was generated as a rift basin during Middle Miocene time and converted to a compressional basin at the latest Late Miocene time due to the changes in plate tectonic conditions (Takano, 2002; Fig. 2). The basin is filled with a thick succession of submarine-fan turbidites, which comprise several types in terms of fan morphology. The variations of the fan types are strongly related to the basin tectonics. Sandy radial fans were dominant during the post-rift phase because there was no distinct topographical control, whereas confined trough-fill turbidite systems were characteristically developed during the basin-inversion and compressional-stress-field stages because syndepositional folding due to compressional stress restricted the distribution of turbidites (Figs. 2, 3 and 4).

In the Plio-Pleistocene successions, submarine-fan systems tended to be developed predominantly during highstand of relative sea level. The Pliocene to Lower Pleistocene sediments of the basin are divided into two third-order depositional sequences, Kkb-III-A and Kkb-III-B in ascending order (Fig. 5), which were formed in response to relative sea-level changes. Temporal and spatial distribution analysis of depositional systems reveals that there are no distinct differences in sedimentation patterns of submarine fans among LST (Lowstand Systems Tract), TST (Transgressive Systems Tract) and HST (Highstand Systems Tract) of the third-order sequences (Fig. 6). The result of sedimentation rate calculation also supports that submarine-fan systems tended to be developed predominantly in the late stage of TST and early stage of HST (Fig. 7). Although submarine fans were also developed during the lowstand stages, the TST and HST submarine fans tended to be larger and coarser than those of the lowstand stages.

This resulted from unique climatic conditions in the Japan Sea at this time (Fig. 8). During highstand of sea level, a warm ocean current flowed into the Japan Sea through the Tsushima Strait (Figs. 1 and 8), resulting in the warming of seawater. Dry and cold monsoon from the northwestern continent induced a large amount of cloud due to evaporation from the warm seawater, causing remarkable precipitation, and a large amount of coarse clastics were supplied into the basin. On the other hand, during lowstand of sea level, a warm ocean current could not flow into the Japan Sea because the Tsushima Strait became shallow or exposed subaerially, resulting in the cooling of seawater. It caused dry weather, because no prominent evaporation took place, and the sediment-supply rate decreased. The other important factors causing the highstand submarine fans are basin tectonics and basin physiography during the deposition. It is possible that tectonic uplift phases of the provenance might coincide in time with the highstand stages, resulting in high sediment-supply potential during the highstand phases. Since the basin originated from a rift basin, there were no enough shelves for sediment accumulation at the basin margin, and changes in sediment-supply potential of the provenance influenced the basin-floor sedimentation directly, rather than the effects of relative sea-level changes.

Reference

Takano, O., 2002, Changes in depositional systems and sequences in response to basin evolution in a rifted and inverted basin: an example from the Neogene Niigata-Shin'etsubasin, Northern Fossa Magna, central Japan. Sedimentary Geology, 152 (1-2), 79-97.

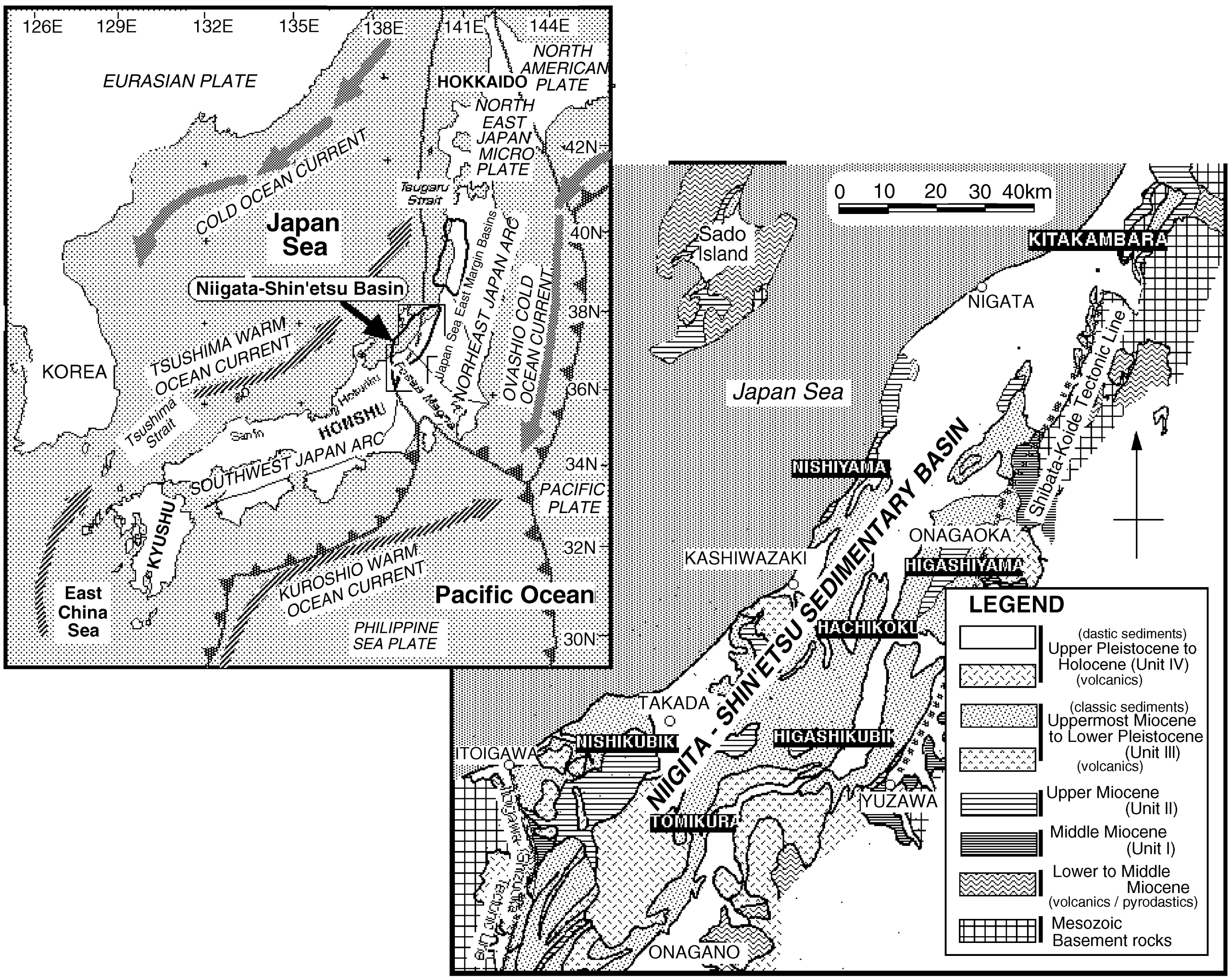

Fig. 1 Index map showing the location of the Neogene Niigata-Shin'etsu basin.

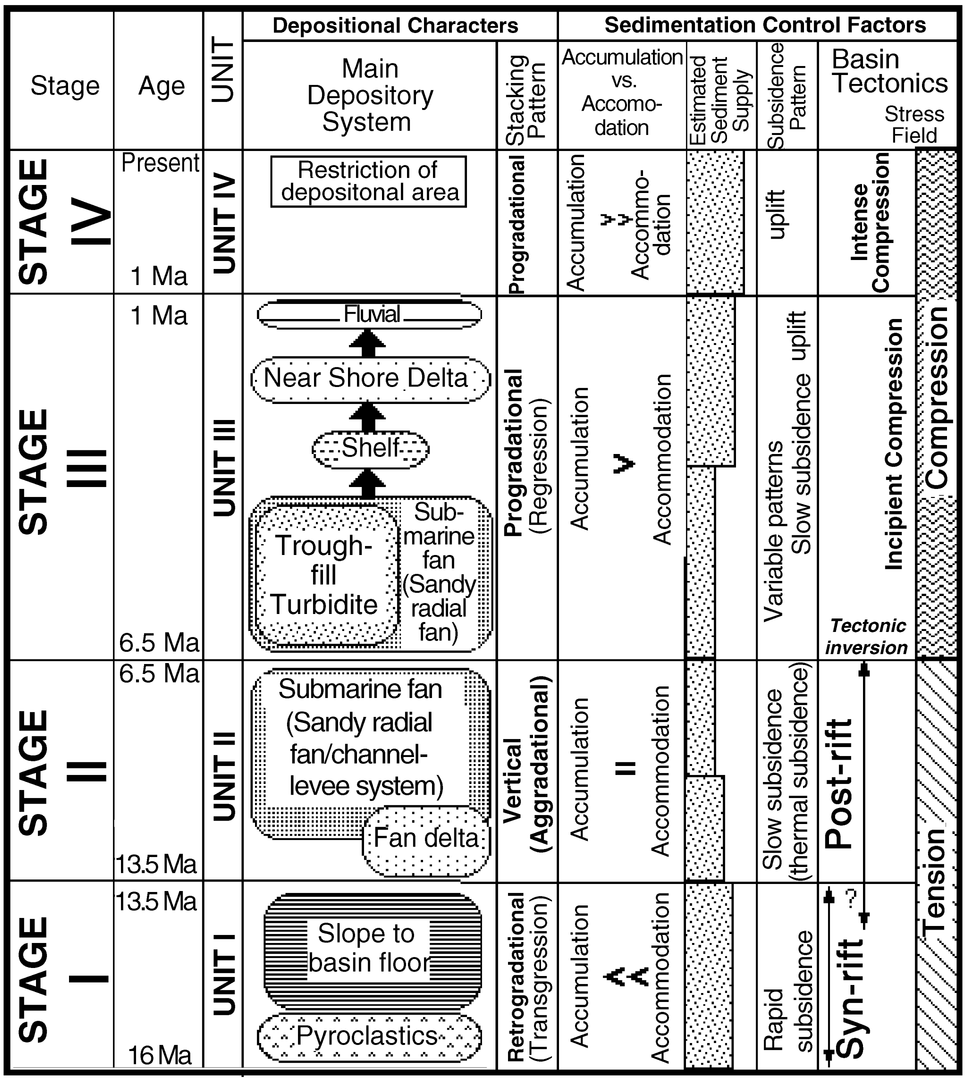

Fig. 2 Tectonostratigraphic division of the Neogene Shin'etsu basin showing the depositional characters and sedimentation control factors of each stage.

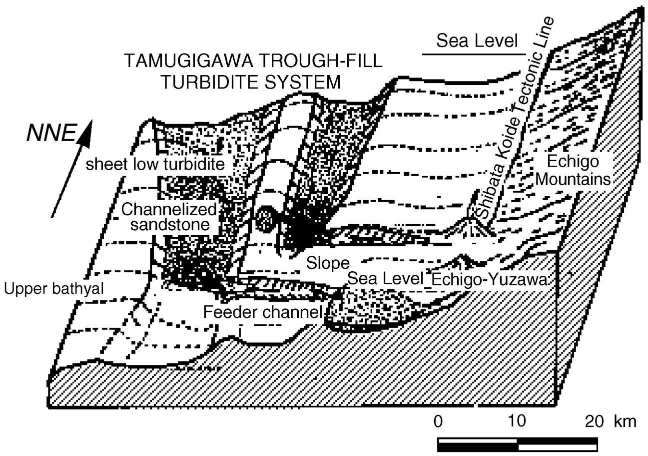

Fig. 3 Schematic depositional model of a trough-fill turbidite system developed during Stage III in the Niigata-Shin'etsu basin.

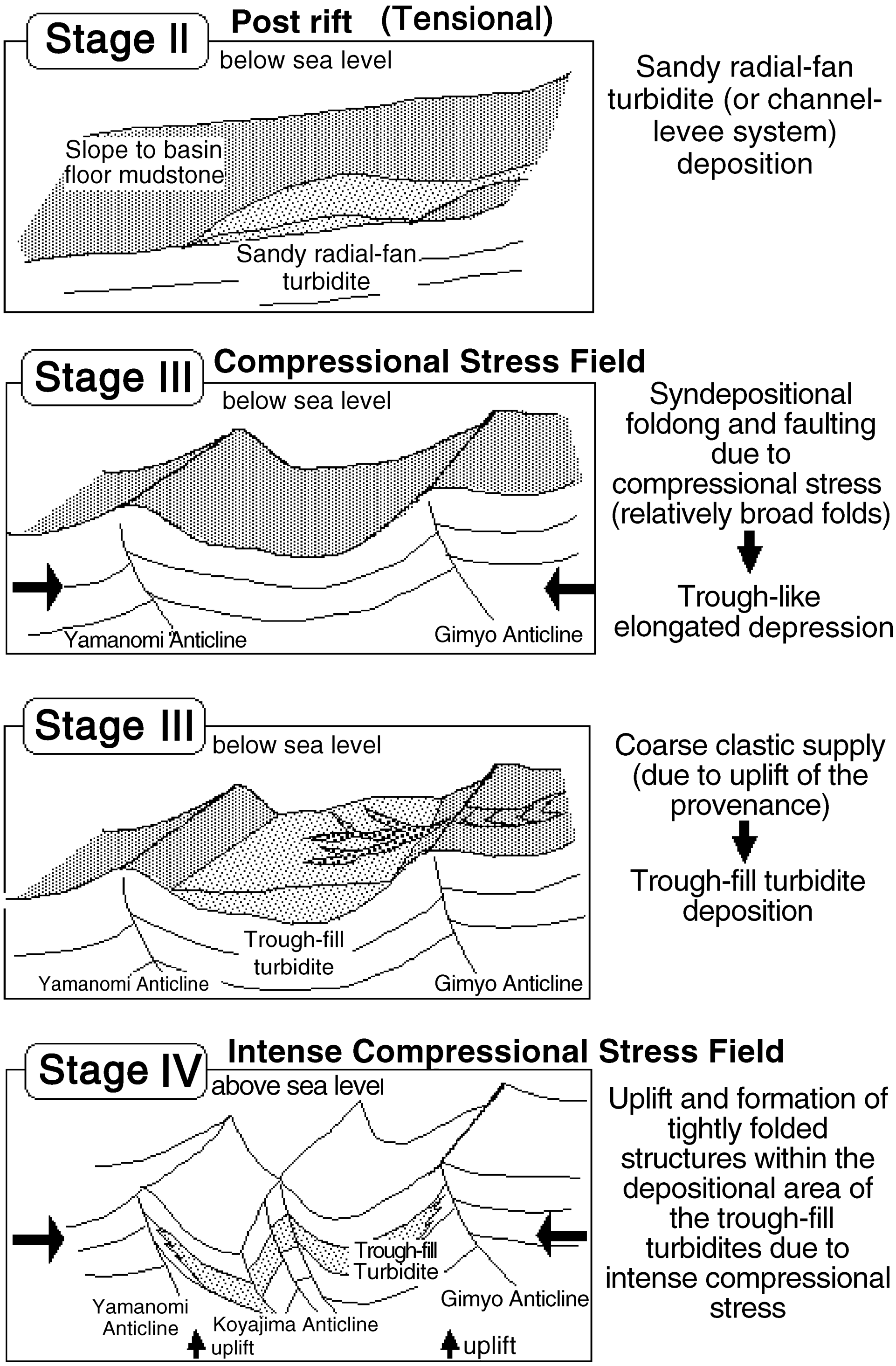

Fig.4 Schematic cartoons showing a process model for the deposition and folding of a trough-fill turbidite system in the Neogene Niigata-Shin'etsu basin.

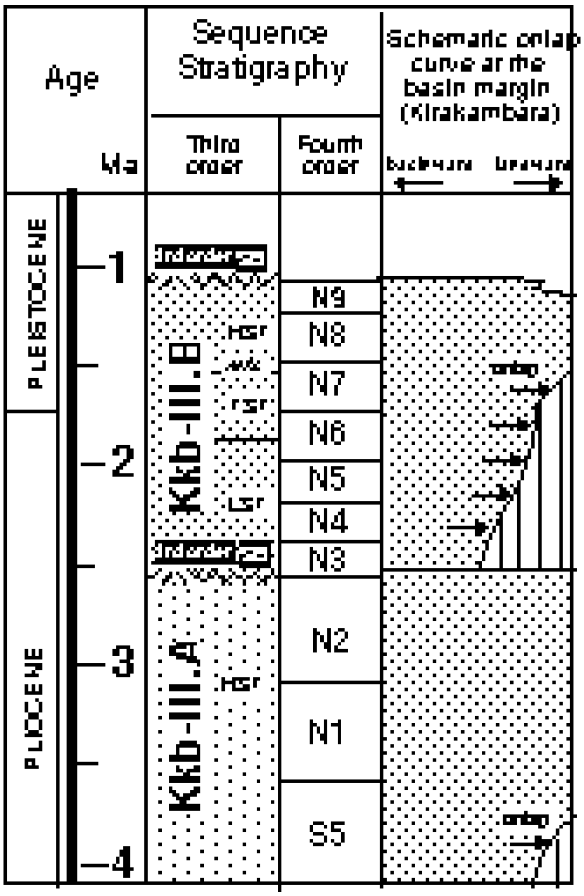

Fig.5 Generalized sequence stratigraphy of the Upper Pliocene to Lower Pleistocene in the Kitakambara area, northern part of the Niigata-Shin'estu basin.

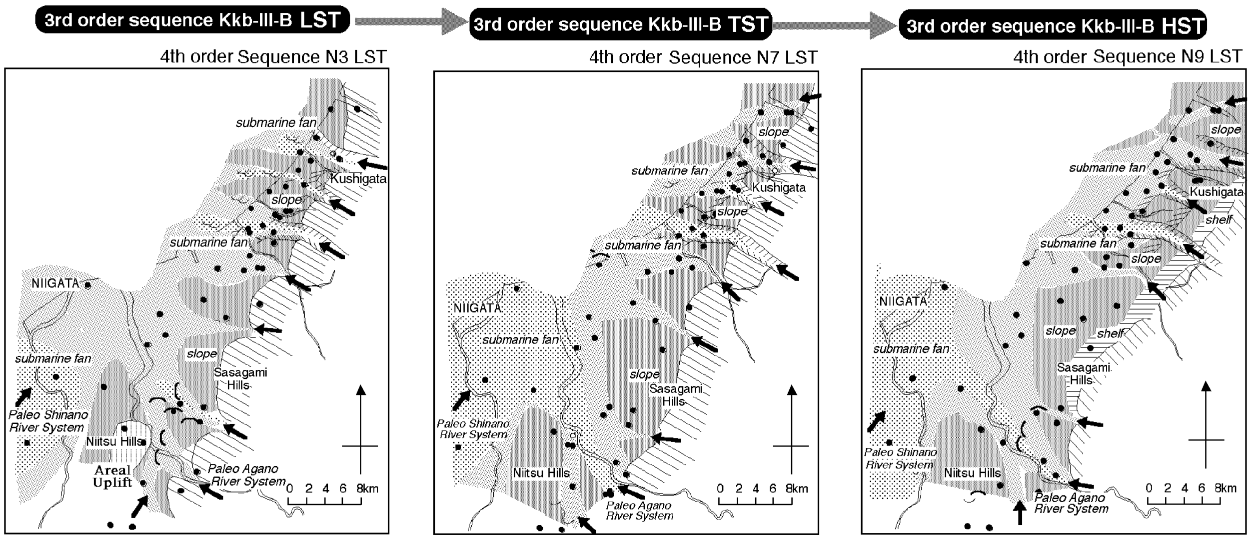

Fig.6 Depositional-system distribution maps for LST (Lowstand Systems Tract), TST (Transgressive Systems Tract) and HST (Highstand Systems Tract) of third-order sequence Kkb-III-B in the Kitakambara area. Note there are few differences in submarine-fan distribution between LST, TST and HST of the third-order sequence.

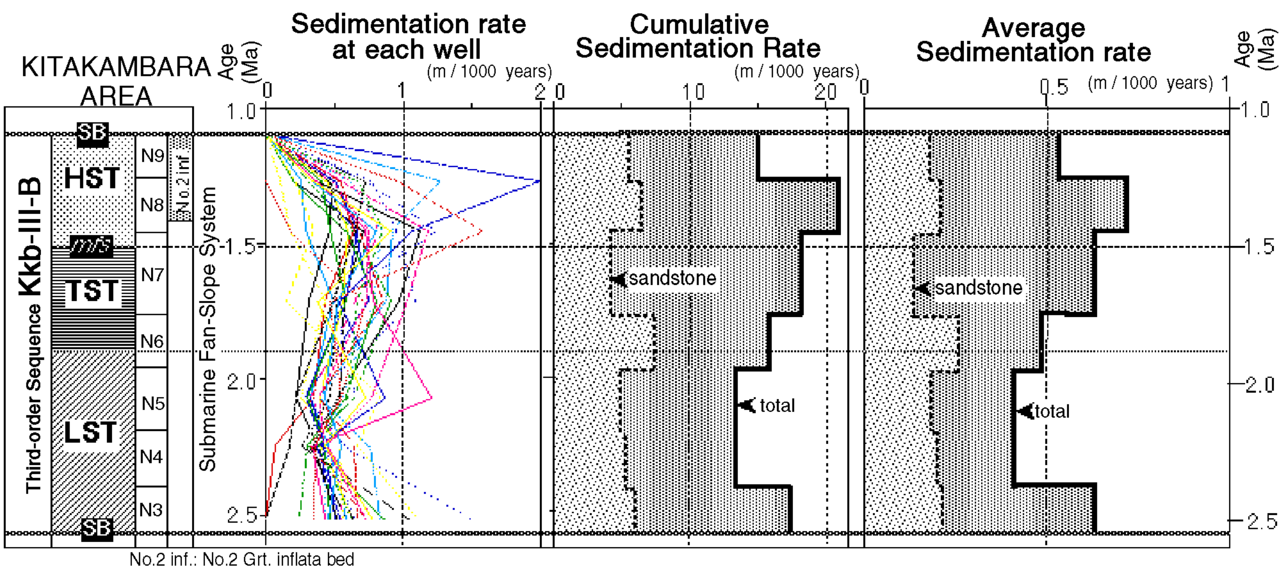

Fig.7 Variation in sedimentation rate in third-order sequence Kkb-III-B. Sedimentation rate was calculated using 30 exploration wells in the Kitakambara area. Note that TST and HST show high sedimentation rate.

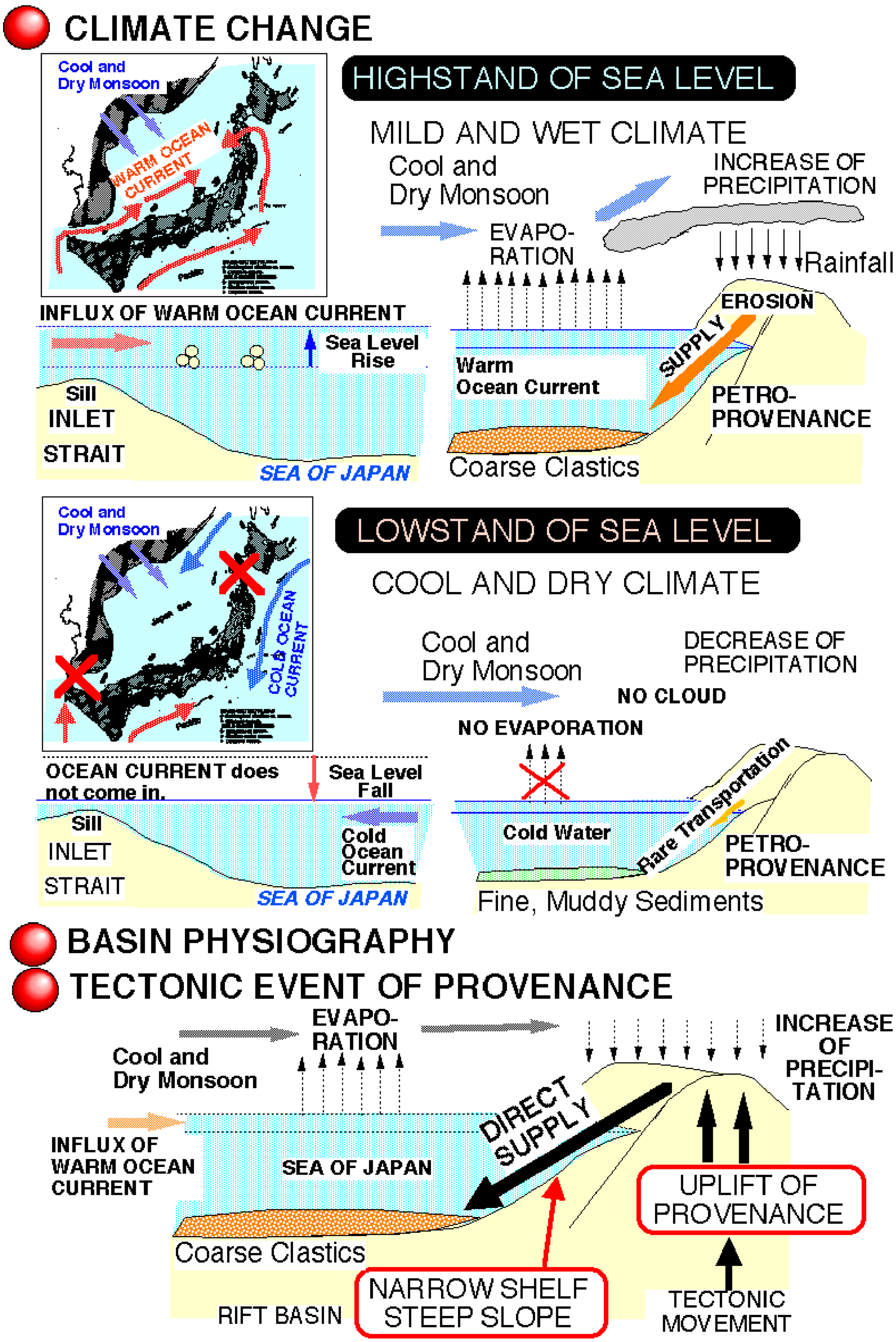

Fig.8 Model diagrams showing factors controlling high sedimentation rate in submarine fan turbidites in TST and HST in the Neogene Niigata-Shin'etsu basin.