Cenozoic volcanism in Sikhote Alin, Far East Russia: Transition of magma type associated with backarc opening

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Many, though not all, volcanic arc-trench systems, and especially those in the Western Pacific, are associated with backarc basins (Taylor and Karner, 1983). Although it has been established that backarc basins are built by breakup and opening of the overriding lithosphere at convergent plate margins, the principal cause of such opening has been controversial. The central problem would be the relative role of the sinking oceanic plate and the mantle activity in the formation of backarc basins. The mechanisms of backarc opening proposed so far may fall into two broad categories: 'passive' processes which emphasize the role of relative plate motions (Chase, 1978; Uyeda and Kanamori, 1979), and 'active' processes which invoke material flow within the mantle wedge to initiate backarc extension (Karig, 1971; Toksoz and Bird, 1977). In order to identify which mechanisms, passive or active, act as a major cause of opening, documentation of the relative timing of opening and associated volcanism is critical, because upwelling of asthenospheric mantle materials, which would cause surface magmatism, may result in thinning and opening of the overriding lithosphere or, on the contrary, it may be induced as a consequence of lithospheric thinning backarc opening. The attention will be paid to magmatism in the northern part of Sikhote Alin, simply because that region was attached to the NE Japan arc. In order to document the magmatic activity more comprehensively, the analyses will cover the whole region of the Northern Sikhote Alin, although previous works focused solely on the coastal range. The final goal of this is to discuss the linkage between such magmatism and the backarc opening event.

K-Ar ages and major/trace element compositions were obtained from 71 fresh lavas from the northern Sikhote Alin, Far East Russia, in order to document the secular variation in volcanism and upper mantle processes during backarc opening. This region is distinct in that it was the home of the NE Japan arc sliver before the opening of the Japan Sea backarc basin. Also, the distribution of lavas from the coastal region to the inner part of the continent is the characteristic feature of this region. Northern Sikhote Alin can be divided into two volcanic province, that is, the East Sikhote Alin (ESAVB) along the Japan Sea coast, the West Sikhote Alin (WSAVB). The volcanic activity in the north Sikhote Alin took place during 40-25 Ma and 20-5 Ma, and was separated by a marked hiatus in volcanism during 25-20 Ma, which is synchronous to the period of the major opening event in the Japan Sea backarc basin. It should be stressed that the volcanic activity during the pre-opening stage of the Japan Sea occurred in the entire ESAVB along Japan sea, whereas no volcanism in the WSAVB. Such an arc-like signature may suggest the location of a arc-trench system in this region before the formation of the backarc basin. On the other hand, the volcanism during 20-5 Ma exhibits spot-like signatures appeared throughout.

All lavas erupted in the ESAVB during 40-25 Ma have compositions typical of subduction magmas, which marked secular variation in lava chemistry, the ESAVB implied to be formed a arc before the opening of the Japan Sea. It is further suggested that the backarc opening is initiated at the volcanic front, rather not in the backarc region. Thus, the present data clearly demonstrate that the opening of the Japan Sea initiated at least 25-20 Ma, earlier than 15 Ma as suggested previous based on paleomagnetic data. On the contrary, the arc magma chemistry is not confirmed for any lava erupted during 20-5 Ma, indicating that such subduction-related volcanism was terminated due to the opening of the Japan Sea. During 20-5 Ma, intraplate-type lavas with typical hotspot magma compositions typifies the Sikhote Alin volcanism and may be caused by mantle upwelling beneath the Cenozoic intraplate basalt province in the northeast China and Far East south Russia.