STRATIGRAPHIC COMPARISON BETWEEN QUENCHED ANGRITES AND KOMATIITES. H. Hayashi[1] and T. Mikouchi[2] [1]Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo, Hongo, Bunkyo-ku, Tokyo 113-0033, Japan, [2]The University Museum, The University of Tokyo, Hongo, Bunkyo-ku, Tokyo 113-0033, Japan, E-mail: h.hayashi@eps.s.u-tokyo.ac.jp.

Introduction: Angrite is one group of basaltic achondrites formed in the early solar system and have two distinct igneous textures, quenched or slowly-cooled. Quenched angrites have older crystallization ages (*ca.* 4564 Ma) compared to slowly-cooled ones (*ca.* 4558 Ma), and they are widely used as good time anchors [e.g., 1]. In our previous study [2] we demonstrated that quenched angrites could be divided into three types by igneous textures. In this abstract we call them “QA1”, “QA2” and “QA3”. QA1 is dendritic (intergrowth of olivine and anorthite), QA2 is relatively coarse-grained and containing anorthites with random orientations, and QA3 is dominant in anorthite laths whose elongated directions are similar for many grains. These textual varieties are related to their cooling rates [2]. NWA 8535 is a dunite angrite, and possibly a cumulate [3] (“QB”). Some quenched angrites contain Mg-rich olivine xenocrysts. We proposed a model of possible geological setting of quenched angrites from calculation of olivine cooling rates, bulk chemical compositions and igneous textures [4] (Fig. 1).

Our proposing igneous body is a lava flow with Mg-rich olivine xenocrysts erupted onto the surface of angrite parent body (APB). Rapid cooling of lava flow with sinking and melting of olivine xenocrysts occurred, which produced textual varieties of quenched angrites, QA1 to QB.

Komatiite on the earth is similar to quenched angrites in several aspects. Komatiite is an ultramafic volcanic rock with >18 wt% MgO [6] while Si and K abundances are low. The liquidus of komatiite magma is close to 1600 ^{o}C. Most komatiites formed in Archean (4.0- 2.5 Ga), and this might be because Archean mantle was far hotter than the modern mantle [7]. Spinifex texture, characterized by large, skeletal, platy blades of olivine or acicular needles of pyroxene, is found in the upper parts of komatiitic flows. The texture is considered to form by relatively rapid crystallization. Stratigraphy of komatiite is suggested by [8] (Fig. 2). Textures vary according to the burial depth, classified into chilled flow top (“A1”), random spinifex (“A2”), plate spinifex (“A3”), foliated skeletal olivines (“B1”) and cumulate olivine (“B2”).

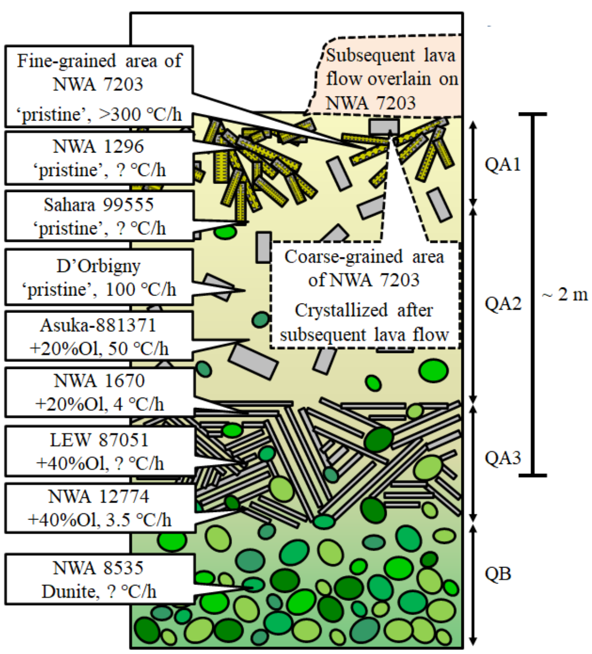

Fig. 1 Schematic illustration showing the stratigraphy of the igneous body for quenched angrites [4]. Burial depth of LEW 87051 is estimated to be around 2 m [5].

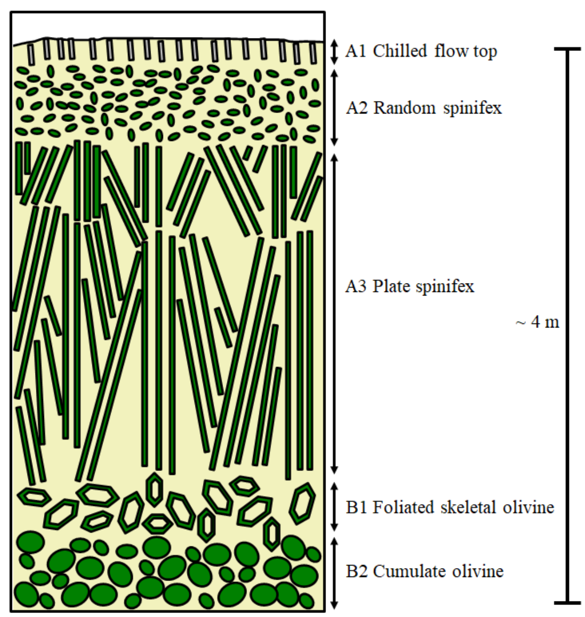

Fig. 2 Schematic illustration showing the stratigraphy of komatiite igneous body after [8].

This study compared characteristics of quenched angrites and komatiites such as chemical compositions, textures and cooling rates to better constrain the geological setting of quenched angrites in APB.

Chemical Compositions: We compared bulk chemical compositions of quenched angrites and komatiites. Bulk chemical compositions of quenched angrites vary according to different incorporation degrees of Mg-rich olivine xenocrysts [4]. Bulk chemical compositions of Sahara 99555 (Sah), D’Orbigny (D’O), NWA 1296 and NWA 7203 are considered as ‘pristine angrite magma’. When we compare bulk chemical compositions of quenched angrites and komatiites, quenched angrite is more Al-, Fe- and Ca-rich, and komatiite is more Si- and Mg-rich.

Textures and Cooling Rates: Similar to the komatiite stratigraphy (Fig. 2), textures of quenched angrites vary by the depth of their formation in the igneous body and QA1 to QB samples would correspond to zones with different depths (Fig. 1).

The QA1 samples/zones of quenched angrites such as NWA 1296 and fine-grained areas of NWA 7203 might correspond to A1 of komatiite because both of them show finest-grained textures within each igneous body. The cooling rate of the fine-grained areas of NWA 7203 is estimated to be >300 ^{o}C/hr [4] and that of A1 is >150 ^{o}C/hr [9], respectively, both giving the fastest cooling rates within each group.

The QA2 samples/zones such as coarse-grained areas of NWA 7203, Sah, D’O and Asuka-881371 (Asuka) might correspond to A2 of komatiite. Minerals in both layers have random orientations of either anorthite (angrite) or olivine (komatiite). The D’O cooling rate is estimated to be about 100 ^{o}C/hr and that of Asuka is about 50 ^{o}C/hr [4]. From the crystallization experiment, the cooling rate of A2 is estimated to be >10 ^{o}C/hr [9], matching those of quenched angrites containing randomly oriented anorthite.

The QA3 samples/zones such as NWA 1670, LEW 87051 (LEW) and NWA 12774 might correspond to A3 of komatiite. A3 contains olivine or pyroxene laths up to 1 m long. Anorthite laths in NWA 1670, LEW and NWA 12774 is up to 1 mm long. Although mineral combinations and grain sizes are quite different, both textures are similar in that they contain oriented minerals. The cooling rate of NWA 1670 is estimated to be about 4 ^{o}C/hr and that of NWA 12774 is about 3.5 ^{o}C/hr [4]. The estimated cooling rate of A3 is 2~5 ^{o}C/hr [9], which is close to those of NWA 1670 and NWA 12774.

Although the cooling rate or formation process of QB is unclear, there is a possibility that NWA 8535 corresponds to either B1 or B2 of komatiite.

Discussion and Conclusion: We compared chemical compositions, textures and cooling rates of quenched angrites and komatiites, and found some striking similarities in their zoning of igneous bodies, corresponding to their textural diversities. This might indicate the geological settings of quenched angrites is equivalent to that of komatiites, although the chemical compositions of the magmas and presence of Mg-rich olivine xenocrysts are different. Hill et al [10] suggested the geological settings of komatiites, that continuous eruption from fissure caused channelized and sheet lava flow. Lava flow is continuous closer to the eruption site and episodic far from the eruption site (Fig. 3). At the surface of APB, a similar eruption event might have occurred. Taking NWA 7203 into consideration, quenched angrites known until now might originate from an igneous body far from the eruption site. This is because NWA 7203 has both fine-grained and coarse-grained areas, and its textual difference was produced by cooling rate change when subsequent lava flow overlay the earlier surface [2].

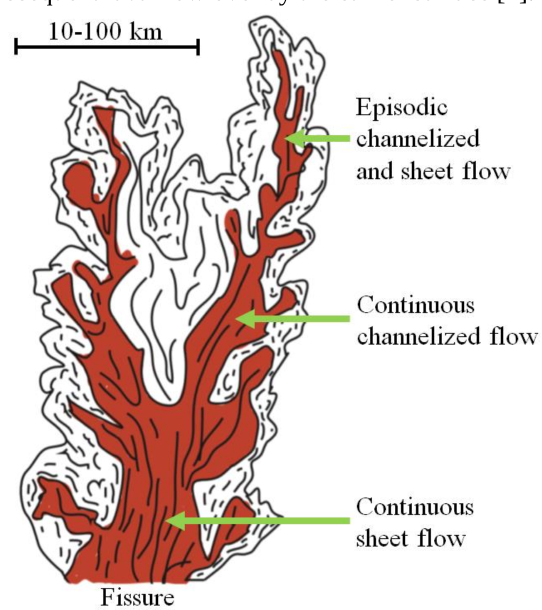

Fig. 3 Schematic illustration of a komatiite flow field, formed by cataclysmic, sustained eruption after [10].

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