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Global Mesozoic and Cenozoic Rift Systems: Constrains on the Tectonic Setting of Mafic Dyke Swarms

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The primary tectonic setting of dyke swarms, especially those formed in the pre-Cambrian era, are under controversy (Peng et al., 2005). However, Mesozoic and Cenozoic rift systems, which are supposed to be the modern prototype of mafic dyke swarms, provide ideal objects for researching favorable tectonic settings for dyke swarms. Therefore, based on the compiling *Global Mesozoic and Cenozoic Tectonic Map* (Li et al., 2016), we reviewed the global Mesozoic and Cenozoic rift systems, and concluded main tectonic processes that dominated the development of Mesozoic and Cenozoic rift systems.

Mantle plume assumes an important tectonic process that forms rift systems. Most of these rift systems take the form of aulacogen, which is the abandoned arm of paleo-trigeminal rift. Mesozoic and Cenozoic examples include West and Central African Rift System (142-101 Ma; Fairhead et al., 2013) and East Africa Rift System (~30 Ma-present; Macgregor, 2015). Meanwhile, in intra-continental environment, three arms of the trigeminal rift can be well preserved, such as the Siberian Permian-Triassic Rift System (Kuskov et al., 2014).

Rift systems are also found in compression environment. Some syn-orogenic rifts were formed in intra-continental environment, including European Cenozoic Rift System (late Eocene to present; Schumacher et al., 2002), South Tibetan Graben (Cenozoic; Jiang et al., 2016), Baikal Rift System (late Oligocene to present; Petit et al., 2015), and Sayan-Tunka Rift System (Lunina et al., 2007). They are oriented perpendicular to the orogeny (Alpine and Himalayan), implying rifting along maximum tension stress. Besides, post-orogenic setting is also favorable for the development of rift systems. For instance, North Sea Rift System was formed on the Caledonian Orogen basement, with two major periods: late Permian to early Triassic and mid Jurassic to early Cretaceous (Duffy et al., 2015).

Some rift systems are associated with mid-ocean ridge

spreading. Worldwide, the spreading mid-ocean ridges interconnect to form the undersea mountain chain. There are two terminations for the ridge chain, Gulf of Suez Rift and Laptev Sea (Lena River) Rift. Gulf of Suez Rift was formed at ca. 24~15.5 Ma as a result of the extension of Red Sea Rift (Abd-Allah et al., 2014). Laptev Sea Rift was formed from late Cretaceous to Neocene (Franke et al., 2001). Both are recognized as the plate boundary between two tectonic plates.

In addition, subduction process may generate extension environment that favors the rifting of lithosphere. Typical examples include the graben systems in North China Craton, and the Basin and Range Province in North America Craton. They are oriented parallel to the subduction zones (Shi et al., 2014; Dickinson, 2002).

In conclusion, our research reveals four kinds of tectonic settings that developed Mesozoic and Cenozoic rift systems: mantle plume upwelling, orogeny, mid-ocean ridge extension, and subduction. Each kind of tectonic setting exhibits particular geometrical pattern. Mantle plume gives rise to triple junction rifts or aulacogen, which are mainly intra-continental settings. Syn-orogenic grabens form parallel multi-strips perpendicular to the compression direction. Post-orogenic setting generates trigeminal rifts superimposed on the orogen basement. Mid-ocean ridge extension leads to linear rift system. And subduction induces back-arc extension. We propose that the various geometrical patterns can be used as indicators for distinguishing the tectonic setting of ancient mafic dyke swarms.

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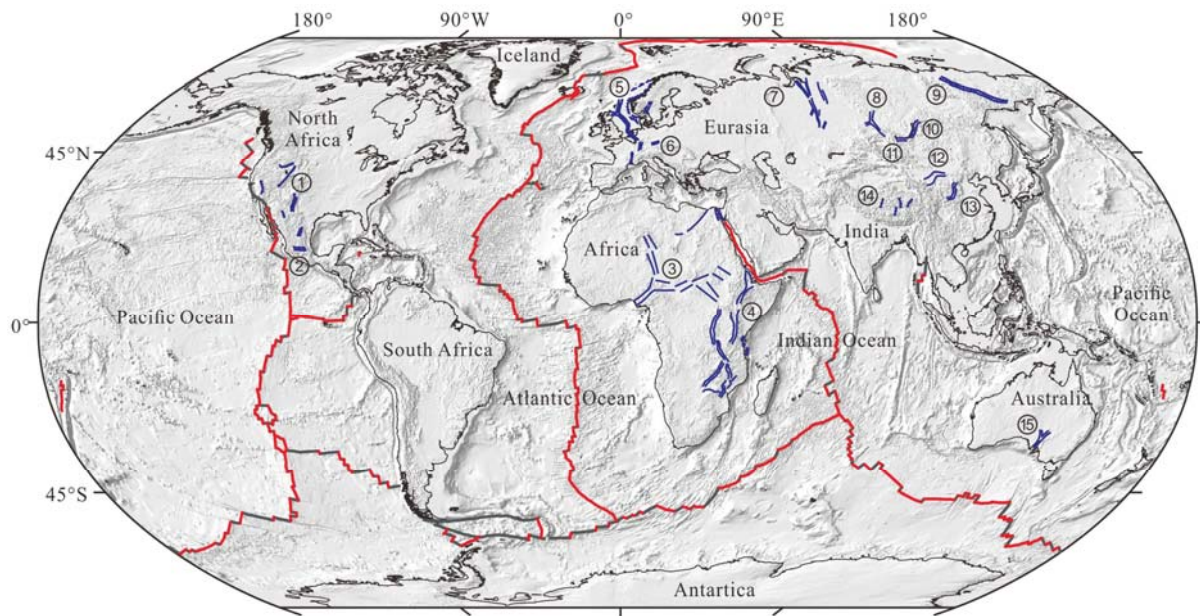


Fig.1. Map showing the distribution of major Mesozoic and Cenozoic rift systems.

①Basin and Range Province; ②Bolanos Graben; ③Western and Central Africa Rift System; ④East Africa Rift System; ⑤North Sea Rift System; ⑥European Cenozoic Rift System; ⑦Orengoy Rift System; ⑧Khudosey Rift System; ⑨Laptev Sea (Lena River) Rift System; ⑩Baikal Rift System; ⑪Sayan-Tunka Rift System; ⑫Hetao Graben; ⑬Shanxi Graben; ⑭South Tibetan Graben; ⑮South Australia Rift System.

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