Suspect terranes and continental accretion biology essay

Science, Biology

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1. Introduction

The concept of terrane was first developed from the studies of Cordilleran orogenic margin of North America in the 1970s. It is discovered that over 70% of the Cordilleran orogenic margin consists of 50 individual crustal fragments with distinctive stratigraphy and structure such as continental fragments, ocean islands and arcs (see Figure 1). The individual crustal fragments were termed terranes later (Coney et al., 1980; Hancock, 1994). Terrane describes a particular kind of stratum which preserves its own distinctive geology included stratigraphic and structural features and is bounded with adjacent stratum by fault and suture zone (Coney, 1989; Hancock, 1994; Howell, 1989). This essay aims to focus on suspect terranes and continent accretion. It will first, feature of the classification of suspect terranes and later discuss the process of continental accretion.

2. Suspect Terranes

Terranes are considered as ‘ suspect’ if their paleogeographic positions with respect to adjoining terranes or to the continental margin are uncertain

(Coney et al., 1980; Howell, 1989; Kearey et al., 2009). Suspect terranes are package of strata which is genetically and spatially unrelated to the adjacent strata which join together (Howell, 1989; Saleeby, 1983). They probably join with each other or continental margin by tectonic transportation after their formation randomly (Coney, 1989; Coney et al., 1980; Schermer et al., 1984). They are exotic to their adjacent continental cratons that they are allochthonous crustal fragments (Howell, 1989; Kearey et al., 2009). 2. 1 Distribution of Suspect TerranesSuspect terranes can be found in orogenic belt along continental margins such as the circum-Pacific belt in Alaska, Siberia, Japan and New Zealand (see Figure 2). The terranes within the orogenic belt are most likely the components of Gondwana and they have transported and collided with Europe, southeastern Asia and the Pacific margins. Suspect terranes can be observed in areas which are not located at mountain range like the regions in Alps near Arabia and Himalaya near India (Nur and Ben-Avraham, 1982). 2. 2 Classification of Suspect TerranesSuspect terranes are generally characterized by their stratigraphy and structure. According to the different lithology, suspect terranes can be classified into four categories, namely stratigraphic terranes, dissupted terranes, metamorphic terranes and composite terranes (Coney, 1989; Howell, 1989; Schermer et al., 1984). 2. 2. 1 Stratigraphic TerranesStratigraphy terranes are characterized by coherent sequence of strata with a distinctive stratigraphic successive. The depositional relations between successive or adjacent lithologic units can be obtained (Coney, 1989; Howell, 1989; Schermer et al., 1984). According to the characteristics of crystalline basement rock within the suspect terranes boundary, stratigraphic terranes can be grouped into four types included continental, continental margin, oceanic and island arc fragments. Stratigraphy terranes with continental fragments consist of old strata and sedimentologic units. The oldest stratum formed in the Carboniferous. The sedimentologic units are characterized by quartz-rich sediments and reflect various depositional cycles (Howell, 1989). Examples of these terranes are the Hercynian massifs of Europe and the Paleozoic basement terranes of Sundaland. The second type of stratigraphy terranes is the one with continental margin fragments. These terranes have similar property with nonturbiditic clastic, carbonate or evaporite sedimentary terranes (Kearey et al., 2009). These terranes consist of shallow to deep marine fluvial or terreatrial sequences that compose of quartzofeldspathic debris shed which is generated from continental margin (Coney, 1989; Howell, 1989; Kearey et al., 2009). These terranes are characterized by massive piles of thick strata associated locally with mélange and high-pressure low-temperature metamorphic assemblages (Howell, 1989). The Shimanto terrane of Japan and the Torlesse terrane of New Zealand are the examples. Another type of stratigraphic terranes is the one with oceanic fragments which correspond to turbidite terranes (Kearey et al., 2009). These terranes consist of mafic and ultramafic rocks sequences or ophiolitic sequences. These terranes are characterized by thick piles of deep-sea sediments (Coney, 1989; Howell, 1989; Kearey et al., 2009). Examples include the Dunnage terrane of Newfoundland and the Hokonue terrane of New Zealand. The last one is stratigraphic terranes with island arc fragments, also named magmatic terranes (Kearey et al., 2009). There terranes compose of igneous rocks and sedimentary debris derived from volcanoes (Howell, 1989). According to the environment of formation, these terranes can be predominantly mafic or felsic. Mafic type is characterized by ophiolites and pillow basalt, and felsic type consists of calc-alkaline plutonic rock and dispersed fragments of old continental crust (Kearey et al., 2009). The Precambrian greenstone belts and the Paleozoic Avalon terrane of the Caledonides orogency are the examples. 2. 2. 2 Disrupted TerranesDisrupted terranes correspond to tectonic and sedimentary mélange terranes (Kearey et al., 2009). These terranes compose of heterogeneous assembly of altered basalt and serpentinite, shallow-water limestone, deep-water chert and greywacke and metamorphic rock fragments which are mainly in blueschist facies (Coney, 1989; Howell, 1989; Kearey et al., 2009; Schermer et al., 1984). These terranes are probably resulted from subduction or transform tectonic movement causing internal shearing or faulting (Coney, 1989; Howell, 1989; Kearey et al., 2009). Examples include the Central Belt terrane of California and the Anglesey mélange terrane of Wales. 2. 2. 3 Metamorphic TerranesMetamorphic terranes are originated from the destruction of the original stratigraphy by metamorphic overprint (Coney, 1989; Howell, 1989; Schermer et al., 1984). These terranes are characterized by recrystallization and a terrane-wide penetrative metamorphic fabric (Howell, 1989; Schermer et al., 1984). The Yukon-Tanana terrane of Alaska is one of the examples. 2. 2. 4 Composite TerranesComposite terranes consist of two or more sub-terranes that amalgamation occurred before accretion onto a continent (Coney, 1989; Kearey et al., 2009; Schermer et al., 1984). The internal complexity of these terranes is poorly understood (Coney, 1989). The Intermontane and Insular Superterranes of the Canadian Cordillera and Avalonia are the examples.

3. Continental Accretion

Before the development of the concept of terrane, plate tectonic evolution of continental growth and orogen has been dominated by collisional orogen involving a Wilson cycle of opening and closing of an ocean basin (Wilson, 1966). However, the model of collisional orogen cannot explain all the formation of orogens and an alternative mechanism which is accretionary orogen has been developed (Cawood et al., 2009). The main difference between collisional orogen and accretionary orogen is the occurrence of orogenesis. For collisional orogen, orogenesis takes place at termination of subduction while orogenesis happens during on-going subduction for accretionary orogen (see Figure 3) (Cawood et al., 2009). The concept of accretionary orogen is continental accretion in which juvenile terranes that have undergone intense deformation during the process of building orogens juxtapose with pre-existing continental margins. The accretion of crustal fragments from continent, ocean and island arc onto the borders of continent influences the growth of continent. It is one of the primary mechanisms of continental growth since Precambrian times. Through the investigation of ancient and active orogens, many cycles of accretion and orogeny are recorded (Kearey et al., 2009). 3. 1 Process of Continental AccretionContinental accretion takes place along subduction zone. The process begins when a terrane separate from its origin by tectonic movement and transport to another grographic position. After that, the terrane may juxtapose with other terranes and this process is known as amalgamation. If the terrane collides with a continental margin, the collision between these two crustal pieces is termed accretion (Coney, 1989; Schemer et al., 1984). The tectonic processes of amalgamation and accretion may be the same (Howell, 1989). During the collision and juxtaposition, continental, oceanic and island arc materials which have relatively thick sequences are often scraped by the subducting plate, resulting in forearc and accretionary wedge. Because of the low density, they are buoyant and tend to uplift and obduct onto the continental margin by thrust fault (Coney, 1989; Kearey et al., 2009). As a result, subduction process is choked by the temporary interruption of buoyant crustal materials (see Figure 4) (Cawood et al., 2009; Kearey et al., 2009). After all the collision and juxtaposition, disruption is likely to carry on and further disperses the accreted fragments through rift dispersion or strike-slip dispersion (see Figure 5) (Howell, 1989). Numerous terranes and rifting stage will be resulted due to dispersion and a new cycle of continental accretion starts (see Figure 6) (Howell, 1989; Schemer et al., 1984).

4. Conclusion

The development of the concept of terrane contributes to a clearer illustration of plate tectonic evolution of continental growth and orogen. Although terranes can be found all over the world along convergent zone, many of these terranes are ‘ suspect’ which their provenance is uncertain. Thus, studies on terranes need to continue to analyze the paleogeographic position and property of different terranes.