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The rôle of Accretionary Wedges in the growth of continents: Asiatic examples from Argand to Plate Tectonics

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"... let us listen to the ancient hymn, the spectacular song of the seas, that has saluted so many chains rising to the light." Argand[3])

ABSTRACT

One of the early triumphs of global comparative tectonics was the recognition of a fairly irregular radial migration of orogenic deformation away from stable continental interiors. Suess interpreted this as continental growth. The theory of continental drift, moulded by Argand's genius into a form capable of answering the demands of continental tectonics, provided the first satisfactory explanation of peripheral continental growth and why it was somewhat haphazard. The composite nature of continents found a ready explanation in the theory of plate tectonics, but suture *zones* were early stereotyped into Salomon-Calvi's suture *lines* (his *Synaphie),* although many orogenic belts do not possess a readily recognisable Indus-type clean suture line. In many mountain belts, zones of continental collision are marked by wide belts of accreted sedimentary rocks, commonly with steep structures, forming trapped accretionary complexes. In his subductionless view of continental drift Argand recognised the importance of accretionary material that he thought had been skimmed off the ocean floor by floating sialic rafts. He portrayed broad, accretionary material-filled suture zones in maps and in sections and contrasted them implicitly with narrow suture lines devoid of such accretionary cushions.

As Argand noticed, the architecture of Asia contains numerous examples of large accretionary complexes. In the Altaids they dominate the structure and in the Cimmerides they play a significant rôle. Only in the Alpides they have a subordinate place in the orogenic architecture, which is a joint function of the size of ocean lost and the amount of sediment supplied.

The presence of giant accretionary complexes in continental architecture has important implications for the structure and composition of the lower crust, the nature of continental anisotropies, and the overall growth of the continental crust.

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[3]) All quotations in this paper from Argand's *La Tectonique de l'Asie* were made from Carozzi's translation with small occasional changes (Carozzi 1977), but the paginations indicated are those of the original. Similarly, the quotations from Suess' *Das Antlitz der Erde* are from the authorized English translation by Sollas (Sollas 1904–1924), in places modified by us to improve the translation, but the paginations are those of the original work. All other non-English quotations were translated freely by us.

ZUSAMMENFASSUNG

Einer der frühesten Triumphe der globalen vergleichenden Tektonik ist die Anerkennung eines unregelmässigen Wanderns der Orogenese von zentralen Kratonen gegen die Ränder der Kontinente gewesen, welches Suess als irregulären kontinentalen Wachstum deutete. Die Kontinentaldrifttheorie, geschmiedet durch Argands Genius in eine, den Forderungen der kontinentalen Tektonik entsprechende Form, gab die erste befriedigende Erklärung des peripheren kontinentalen Wachstums und warum dieser unregelmässig vor sich gehen sollte. Obwohl der kompliziert zusammengesetzte Aufbau der Kontinente im Rahmen der Plattentektonik eine einfache Erklärung fand, wurden die kontinentalen Kollisionszonen rasch in die Naht*linien* ("Synaphien") von Salomon-Calvi stereotypisiert, ungeachtet des Fehlens solcher Indus-Sutur-ähnlicher Linien in vielen orogenen Gürteln, wo die Kollisionszonen durch breite Anhäufungen früherer Akkretionskeile markiert sind. Trotz seiner subduktionslosen Auffassung der kontinentalen Wanderungen hat Argand die Wichtigkeit solchen angehäuften ozeanischen Materials anerkannt. Er stellte sie in Karten und Profilen zeichnerisch dar und hob den Unterschied zwischen diesen und den linearen Nahtzonen implizit hervor.

Wie bereits von Argand erkannt, befinden sich viele Beispiele grosser Akkretionskeile in der Architektur Asiens. Dominant sind sie in der Struktur der Altaiden und spielen auch eine nicht unbedeutende Rolle in den Kimmeriden. Eine untergeordnete Stellung nehmen sie nur im orogenen Aufbau der Alpiden ein. Existenz und Ausmass der Akkretionskomplexe scheinen eine Funktion der Grösse des abgeführten Ozeans und der Sedimentzufuhr zu sein.

Das Vorhandensein gewaltiger Akkretionskeile im Aufbau der kontinentalen Kruste hat sehr wichtige Implikationen für die Struktur und die Zusammensetzung der unteren Kruste, für die Beschaffenheit der krustalen Anisotropien und für das allgemeine Wachstum der Kontinente.

1. Introduction

The purpose of this paper is to present some speculations on how the continental crust may have been constructed through the accumulation, and consolidation by magmatism and metamorphism, of accretionary wedges formed during the destruction of oceans. This is related below on Asiatic examples and within the framework of an historical sketch of the evolution of the relevant ideas, in which Emile Argand appears as the leading actor with his prophetic pronouncements on the tectonics of Asia. The speculations we develop suggest answers to such questions as to why in some places the lower continental crust may consist of up to 90% of pelitic material (e.g. Reid et al. 1989, p. 378 and the references cited therein); why the lower crust is seen commonly to be complexly layered (e.g. Brown et al. 1986); and why in Central Asia suture *lines* similar to the one along the Indus and the Yarlung Zangbo in the Himalaya (Gansser 1980) are so rare. All these features seem to result from the widespread occurrence of an hitherto little-considered type of an orogenic belt, in which accretionary wedges are by far the most dominant component. Owing to its prevalence in the structure of areas in Asia inhabited almost exclusively by Turkic peoples[4]), Şengör (in press) called this type of orogenic belt the *Turkic-type* (see also footnote 18 below). The Turkic-type

[4]) The Turkic peoples are those that are historically and linguistically connected with the T'u-chüeh, a name given by the Chinese to a nomadic people who in 552 AD founded under the leadership of Bumin Khagan a vast empire that stretched from the upper course of the Amur River to the Black Sea and that covered much of the area of the Altaids and the Cimmerides (cf. Şengör 1987 and Fig. 1). Although the earlier Hsiung-nu (the *Kun*, probably originally meaning "man") who had founded a similar empire under Mao-tun in the second century B.C. were also Turkic, the T'u-chüeh were the first Turkic people to leave a written record. In addition to the Turks of the present-day Turkey, the Uzbek, the Kazakh, the Kirgiz, the Turkmen, the Yakut and the Uighur (Uygur) constitute, among others, the most important Turkic peoples.