Bali–Lombok Gap: A Distinct Geo-Biologic Border of the Wallace Line

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Introduction

"Bali and Lombok Islands located to the east of Java are very interesting for several reasons. Only on these two islands Hinduism exists in Indonesia. Both islands represent different ends of two zoological realms in the East. The islands are similar in shapes and physical characteristics, but they are different in their floras and faunas." (Wallace, 1863)

The "Wallace Line", a line that divides faunal distribution, came into being in 1863 and was named after Alfred Russell Wallace, the great English naturalist travelling the 'Malay archipelago' or the Indonesian islands from 1854-1862. The Wallace Line separates the Oriental (Asian) fauna to the west from the Australasian fauna to the east (Fig. 1). The original Wallace Line ran between Bali and Lombok, extending northward between Borneo/Kalimantan and Sulawesi, and between the Philippines and Indonesia. The Asian animal community includes such mammals as rhinoceroses, orang-utans, tapirs, tigers, and elephants. Animals related to Australian fauna include birds such as cockatoos, birds of paradise, marsupials and cuscuses.

Bio-Geological Aspects of Wallace Line

Wallace did not believe that accidental dispersal events in ecological time explained mammalian and avian distributions within the archipelago. Instead, he linked geological connection to biological diversity. "Facts such as these can only be explained by a bold acceptance of vast changes in the surface of the earth", Wallace stated in a paper with the title "On the Zoological Geography of the Malay Archipelago" presented to the Linnaean Society on 3 November 1859.

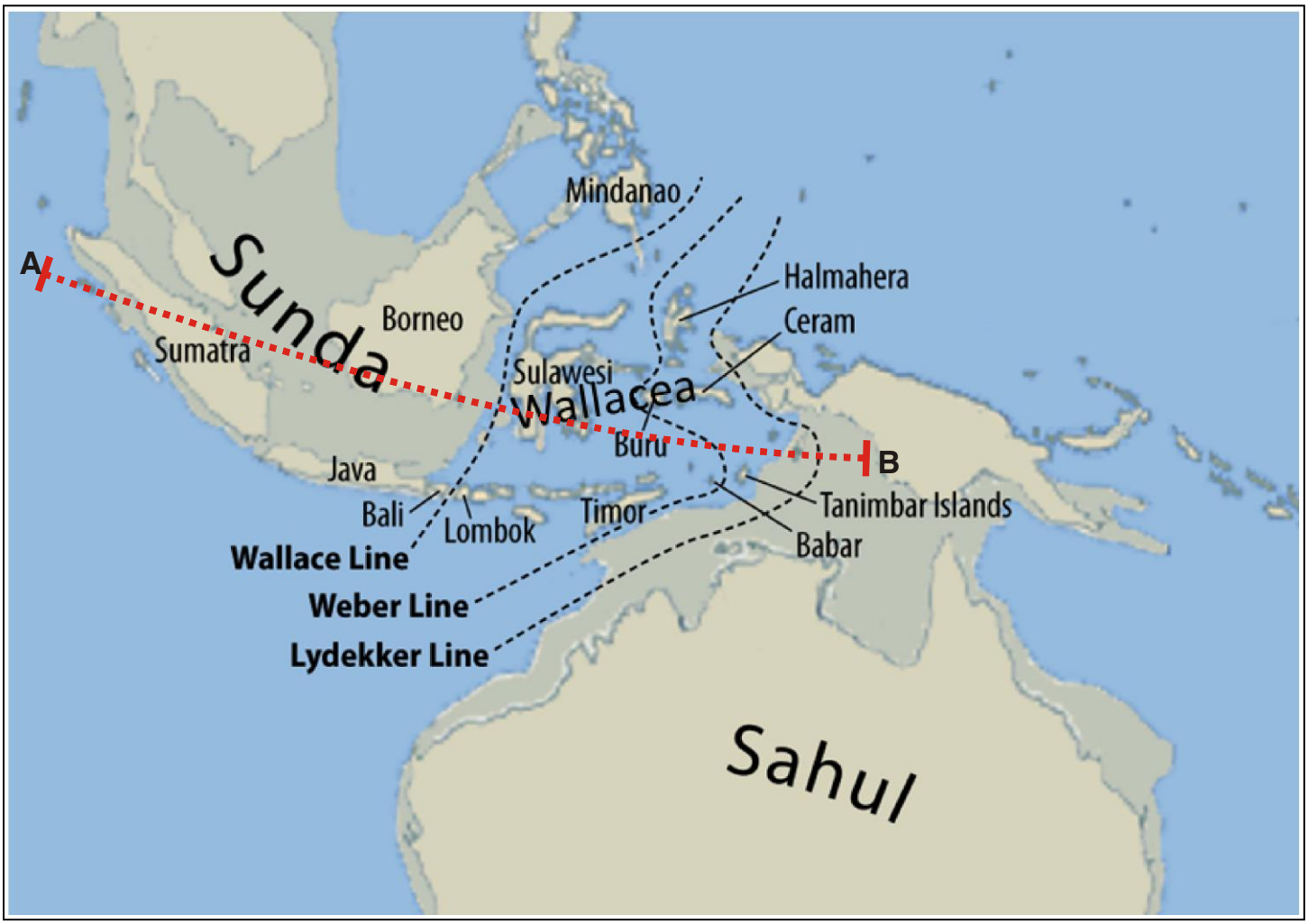


Figure 1. *The Wallace Line runs between Bali and Lombok. It geologically marks the border of the Sunda Shelf to the east. Bali is the easternmost island sitting on the Sunda Shelf. (modified Wikipedia, 2012)*

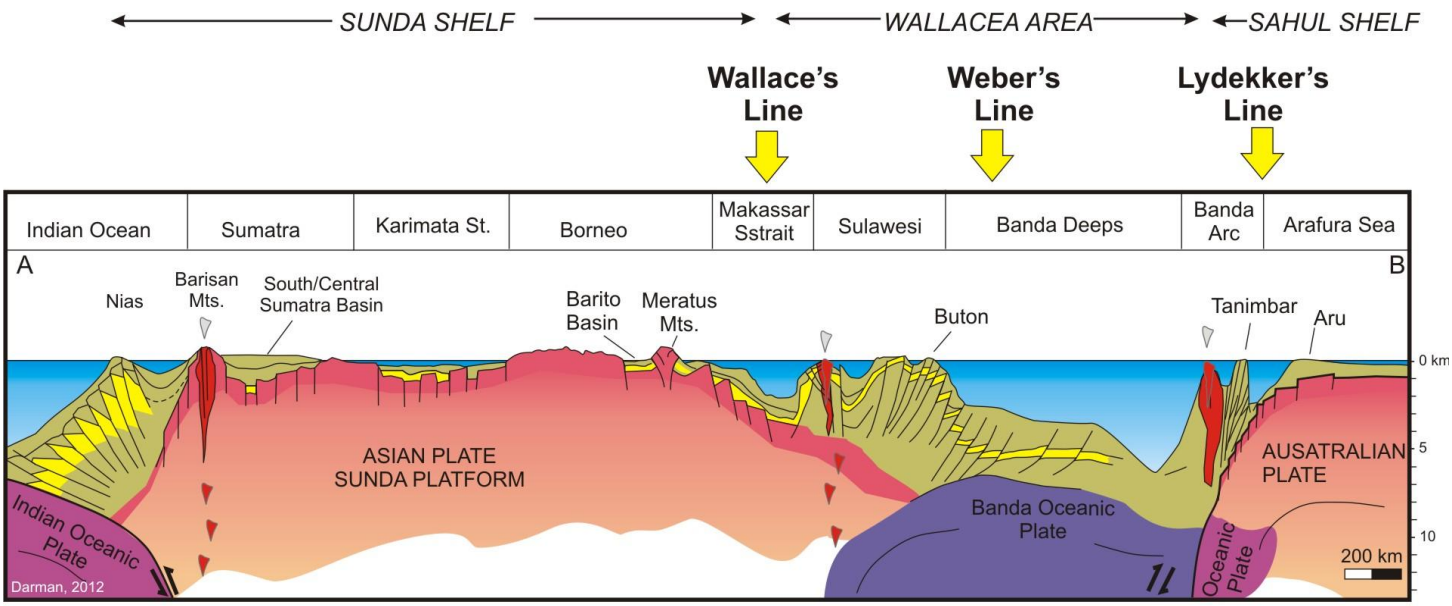


Figure 2. *A schematic cross section across Indonesia showing the relationship of Sunda Shelf, Wallacea Area and Sahul Shelf. See Figure 1 for location. Wallace's line is located between Sunda Shelf and Wallace Area, close to the border between two tectonic plates (source Darman, 2012 in prep.)*

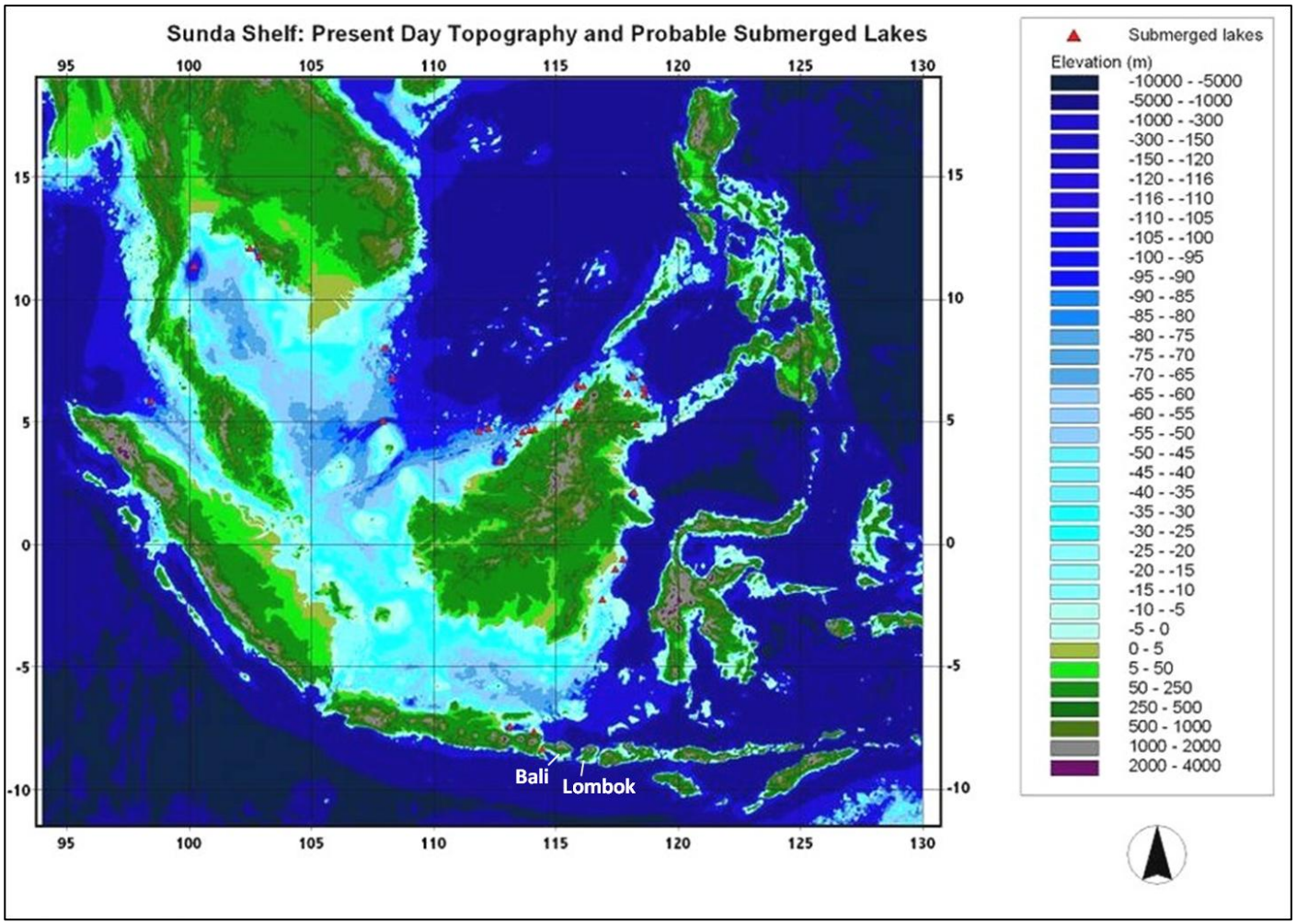


Figure 3. *Bali and Lombok sit on different substrates. Bali sits on shallow shelf of the easternmost part of Sunda Shelf. By contrast, Lombok sits on the deep Flores Sea. This difference creates a geological gap between Bali and Lombok affecting faunal distribution in both*

Therefore, although the Wallace Line was primarily a biologic line, already since the beginning Wallace thought that the line could also have a geologic meaning. This short note discusses geologic control of the Wallace Line between Bali and Lombok.

Currently it is known that the position of the line is geologically-dependent, as a result of plate tectonic movements. Geologically, the physiographic configuration of Indonesia consists of three parts: the Sunda Shelf on the west, the Arafura/Sahul Shelf on the east, and the Wallacea area in between (Figures 1 and 2). The islands of Sumatra, Kalimantan, Java and Bali lie on the Sunda Shelf and are therefore the part of Asian Block/Sundaland. Papua lies on the Arafura/Sahul Shelf and is part of the Australian Block. The area between these two shallow seas is known as Wallacea, encompassing Sulawesi, Maluku and smaller islands called the Lesser Sunda islands, starting with Lombok on its westernmost part (Figure 1).

Since Bali is part of the Asian Block and Lombok is part of the Wallacea region, the area separating Bali and Lombok is a geological gap, occupied the deep Lombok Strait. It connects the eastern part of the Java-Flores Seas to the Indian Ocean. The strait is 20 to 40 km wide, 60 km long, and 250 m deep. The Lombok Strait is one of the main passages for the Indonesian major through flow current that exchanges water between the Indian Ocean and the Pacific Ocean.

Conclusions

Understanding the biogeography of the region depends on understanding the relationship of ancient sea levels to the continental shelves (Figure 3). Wallace's Line is geographically critical when the continental shelf contours are examined; it can be seen as a deep-water channel that marks the southeaster edge of the Sunda Shelf linking Borneo, Bali, Java, and Sumatra underwater to the mainland of southeastern Asia. Likewise Australia is connected via the shallow sea over the Sahul Shelf to New Guinea.
During ice age glacial advances, when the ocean levels were up to 120 metres (390 ft.) lower, both Asia and Australia were united with what are now islands on their respective continental shelves as continuous land masses,

Bali is a continental island that sits on the continental shelf called Sunda Shelf, currently separated from the mainland by a sea strait. By contrast Lombok is an oceanic island; it rises from the ocean floor in isolation and is not part of the continental shelf. Both Bali and Lombok are parts of Sunda inner volcanic arc, formed after the mid-Miocene (< 15 Ma). Both islands appeared above sea level during the late Miocene-Pliocene.

Biologists believe it was the depth of the Lombok Strait that isolated animals on either side. When the sea levels dropped during the Pleistocene ice age, the islands of Bali, Java and Sumatra were all connected to one another and to the mainland of Asia. They shared the Asian fauna. The Lombok Strait's deep water kept Lombok and the Lesser Sunda islands in isolation from the Asian mainland. These islands were colonized by Australasian fauna.

Ornithologist G.A. Lincoln studied birds in Java, Bali, Lombok and Sumbawa, on either side of the Wallace Line in the 1970s (van Oosterzee, 1997). He found that on Java and Bali the birds were nearly all Oriental and dominated by the Oriental Bulbul. On crossing the Wallace Line from Bali to Lombok the birds were predominately Australian.

but the deep water between those two large continental shelf areas was, for over 50 million years, a barrier that kept the flora and fauna of Australia separated from those of Asia. Wallacea area consists of islands that were never recently connected by dry land.

References

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