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WHAT IS THE MAIN FACTOR CONTROLLING THE SUKADANA BASALT IN THE SUMATRA BACK ARC?

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ABSTRACT. The mechanism of the presence of the Sukadana basalt in the back arc of Sumatra is still an enigma, especially since the Sukadana basalt has a wide coverage area in Sumatra Island and even the Sunda Arc. In this study, we used the published research data as the main contributor to an in-depth analysis to determine the mechanism of the presence of Sukadana basalt in the back arc. This study is supported by other studies from different regions around the world. These strengthen our conclusion that the emergence of Sukadana basalt on the surface is controlled by extensional deformations associated with the northwest-southeast-trending normal fault, which are formed by the mechanism of gravitational subsidence due to the movement of the Sumatra fault. In this study we suppose that the Nishimura fracture is a sinistral strike-slip fault as it is consistent with the Riedel shear model.

KEYWORDS: Sukadana basalt; back arc; Sunda Strait; Sumatra fault; normal fault

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SHORT COMMUNICATION

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ЧТО ЯВЛЯЕТСЯ КОНТРОЛИРУЮЩИМ ФАКТОРОМ БАЗАЛЬТОВ СОКАДАНА СУМАТРИНСКОЙ ОСТРОВНОЙ ДУГИ?

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АННОТАЦИЯ. Механизм присутствия базальтов Сокадана в Суматринской островной дуге до сих пор остается загадкой, тем более что базальты Сокадана имеют очень широкую зону охвата, включающую в себя Суматру и даже Зондскую дугу. В данной статье использованы опубликованные исследовательские данные в качестве основного материала для проведения углубленного анализа с целью определения механизма присутствия базальтов Сокадана в островной дуге. Результаты данного исследования подтверждаются другими исследованиями из разных регионов мира, что делает полученные научные выводы более весомыми. Авторы статьи считают, что выход базальтов Сокадана на поверхность контролируется деформациями растяжения, связанными с системами сбросов северо-западного – юго-восточного простирания, которые формируются по механизму гравитационного опускания за счет движения Суматринского разлома. В этом исследовании также высказано мнение, что разлом Нишимура является левосторонним сдвигом, поскольку он согласуется с моделью Риделя.

КЛЮЧЕВЫЕ СЛОВА: базальты Сокадана; островная дуга; Зондский пролив; Суматринский разлом; сброс

ФИНАНСИРОВАНИЕ: Данная публикация является частью докторской подготовки одного из авторов. Исследование выполнено при финансовой поддержке Суматринского технологического института в контексте программы докторских стипендий.

1. INTRODUCTION

The Sukadana Basalt Province is located in the back arc of Sumatra, precisely in the province of Lampung, Indonesia (Fig. 1, a). The Sukadana basalt province is very close to the Sunda Strait which is a transitional zone between oblique subduction in Western Sumatra and perpendicular subduction in Southern Java [Barber et al., 2005; Huchon, Le Pichon, 1984; Malod et al., 1995]. The impact of these different patterns of subduction has indirectly led to the formation of the Sunda Strait grabens since the Late Miocene [Susilohadi et al., 2009]. However, the relationship between the development of the Sunda Strait and the emergence of Sukadana basalt in the back arc of Sumatra is still not clearly understood. In addition, the cinder cones found in the Sukadana basalt province can form four lineament patterns that are believed to be related to the direction of the main structures controlling the presence of Sukadana basalt on the earth's surface (Fig. 1, b). However, which pattern is correct? This study seeks to answer the question.

This study will determine the mechanism of the emergence of Sukadana basalt on the surface, including the structure type and its trend, and develop a new tectonic model for the southern Sumatra region.

2. METHOD

The method used was involved in an in-depth analysis of the studies conducted by [Susilohadi et al., 2009; Pramumijoyo, Sebrier, 1991]. Both studies focused on the Sunda Strait region. We observed that there is a connection between these two studies. We integrated the results of both studies to obtain a more complete and a clearer picture of the geological and tectonic structures in the Sunda Strait, including our study area (Sukadana basalt province). In addition, to confirm the results of our analysis, we also used the published research data from other regions in the world related to the occurrence of basalt in continental plate.

3. RESULTS AND DISCUSSION

In work [Susilohadi et al., 2009] stated that the Sumatran fault began to form during the Middle Miocene. The formation of this fault initiated the opening of the Sunda Strait in the early Late Miocene. The opening of the Sunda Strait was controlled by normal faults, indicating that the opening was an extensional deformation. The Sumatran fault is believed to continue to the southern part of West Java, resulting in the formation of a pull-apart basin in the western part of the Sunda Strait.

The opening of the western part of the Sunda Strait triggered extensional deformation in the eastern part of the strait. However, the type of deformation that occurred was not directly caused by gravitational subsidence rather than by the movement of the Sumatran fault (tectonic setting) [Pramumijoyo, Sebrier, 1991]. This extensional deformation gave rise to the formation of normal faults in the Panjang, Menango and West Banten coastal areas (Fig. 2). In the Panjang area, where Mount Rajabasa is also located, normal fault is evident from the contrasting morphological changes from steep hills to coastal plains. An interesting feature of the Panjang normal fault is its pattern parallel with the Sumatran fault. This parallel pattern can be observed in the Sukadana basalt province, which also has a northwest-southeast pattern (see Fig. 1, b; Fig. 2). The surface

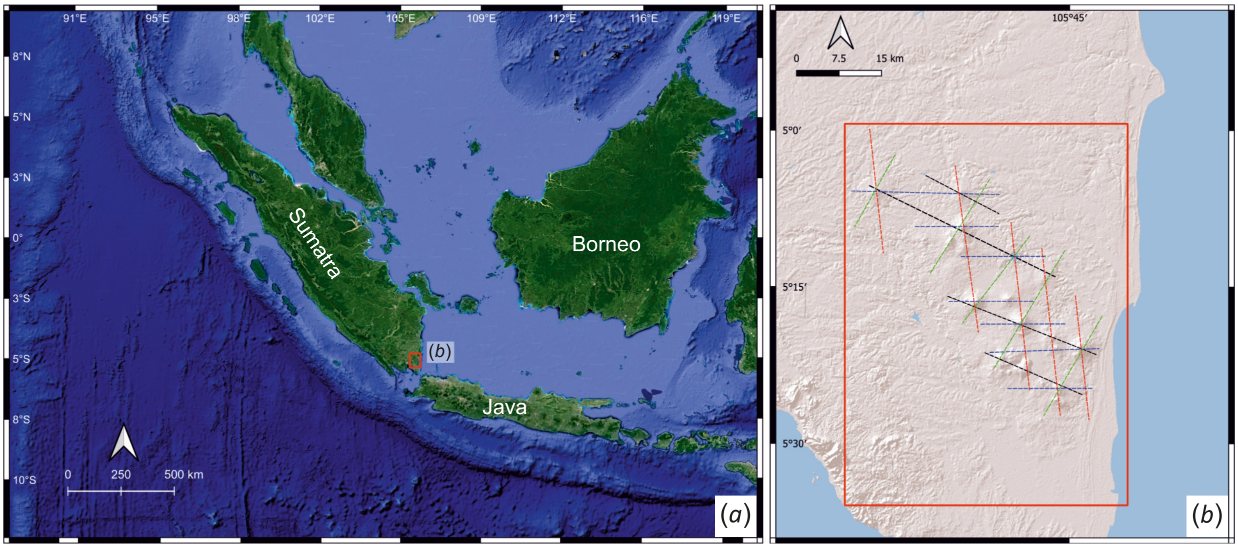

Fig. 1. The position of Sukadana basalt is located in the Lampung province and the back arc of Sumatra(*a*), and four lineament patterns of cinder cones (*b*). These are believed related to the direction of the main structures controlling the presence of Sukadana basalt on the earth's surface.

Рис. 1. Базальты Сокадана в провинции Лампунг и Суматринской островной дуге (*a*) и четыре линеамента в зоне шлаковых конусов (*b*). Линеаменты, предположительно, связаны с направлением основных структур, контролирующих размещение базальтов Сокадана на поверхности Земли.

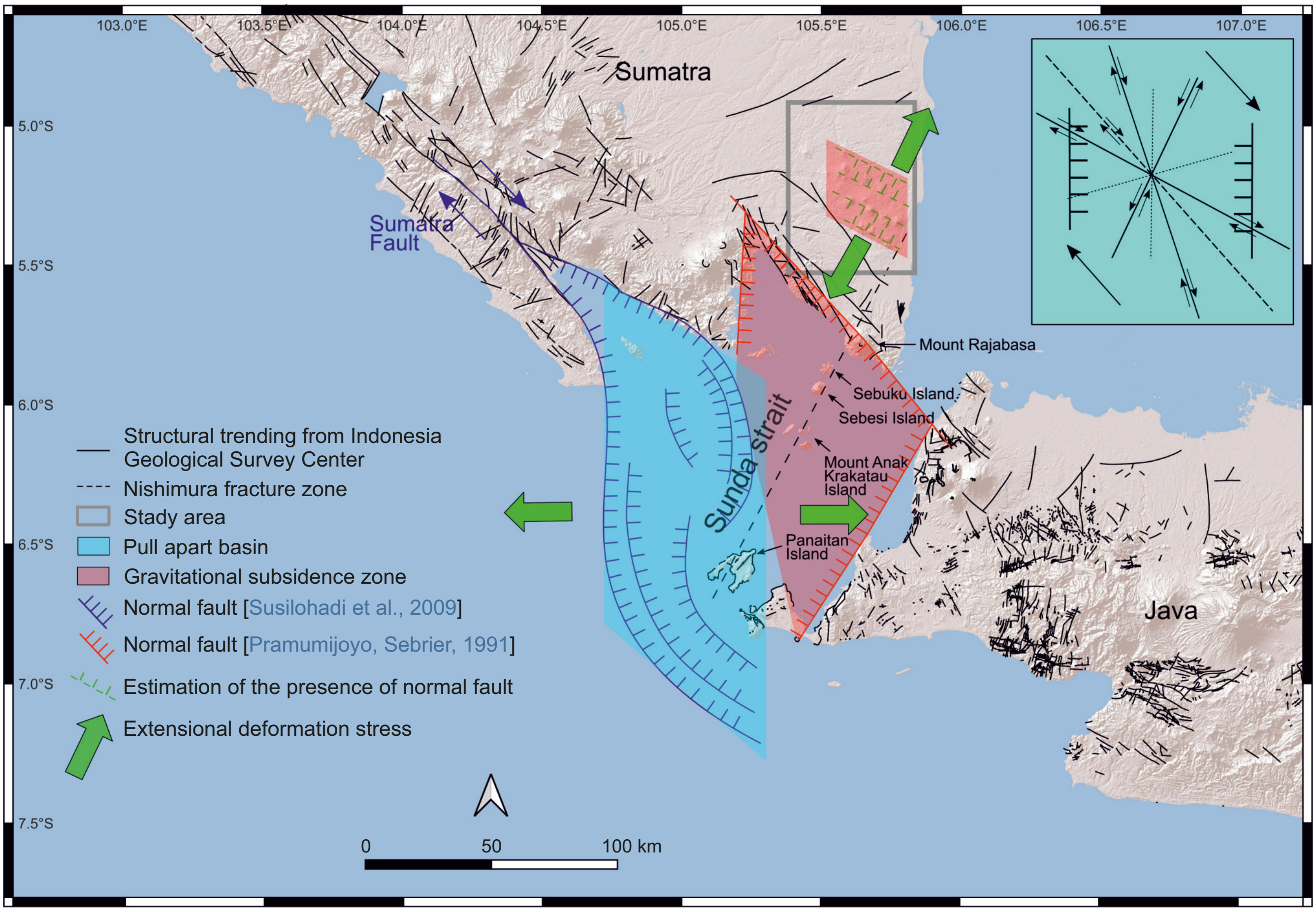

Fig. 2. Integrated structural interpretation [Pramumijoyo, Sebrier, 1991; Susilohadi et al., 2009], interpretation of normal faults in the Sukadana basalt, and the comparison between the Nishimura fracture and the Riedel shear model (insert figure).

Рис. 2. Интегрированная структурная интерпретация [Pramumijoyo, Sebrier, 1991; Susilohadi et al., 2009], интерпретация сбросовых нарушений базальтов Сокадана и сравнение разлома Нишимура с моделью Риделя (врезка).

structural pattern revealed by the Geological Survey Center of Indonesia is the same as those of the Panjang fault and Sumatra fault. This confirms the existence of the Panjang fault and its orientation parallel with the Sumatra fault.

The Sukadana basalt province is located not far from the Panjang normal fault, approximately 40 km north of it. As explained in the previous paragraph, the pattern of the Sukadana basalt province has a northwest-southeast direction that is parallel to the Panjang fault. Their close proximity and similar structural direction imply that the Sukadana basalt province has the same genesis as the Panjang fault. Furthermore, the Quaternary age of the Sukadana basalt province [Nishimura et al., 1986; Soeria-Atmaja et al., 1986] is an additional confirmation that the formation of the fault controlling the presence of Sukadana basalt on the surface is coeval with the Panjang fault.

The emergence of the Sukadana basalt magma on the earth's surface is controlled by normal faults resulting from gravitational subsidence. Long before the Quaternary age, the process of subduction rollback occurred during the Late Eocene till the Early Miocene [Pubellier, Morley, 2014]. This process causes the back arc experienced extensional deformation [Chen et al., 2016; Schellart, Moresi, 2013; Xue et al., 2022]. There is a possibility that the normal fault in the Sukadana basalt is a reactivated pre-existing fault. Furthermore, we believe that the presence of the Sukadana basalt on the surface is controlled by normal faults because the most likely structure for magma to emerge at the surface is an extensional fault [Ayalew et al., 2018; De Souza et al., 2013; Faccenna et al., 2010; Shahraki, 2013; Wang et al., 2015; Yan et al., 2018; Zi et al., 2019].

In addition to the mechanism of the presence of Sukadana basalt on the surface, we also highlight the Nishimura volcanic lineament extending across the Sunda Strait which stretches from the Panaitan Island along the Anak Krakatau, Sebesi and Sebuku islands, the Rajabasa Volcano to the Sukadana basalt plateau, from SSW to NNE [Harjono et al., 1991; Nishimura et al., 1986]. The presence of this volcanic configuration is believed to be controlled by an unknown type of geological structure. Observed configuration of the Sumatra strike-slip fault that continues to the west of the Sunda Strait and the Nishimura volcanic lineament implies matching with the Riedel shear model (Fig. 2). Therefore, the type of fracture that controls the presence of the Panaitan, Anak Krakatau, Sebesi and Sebuku islands is a sinistral strike-slip fault. This interpretation is also supported by the similarity of geochemical characteristics, namely the calc-alkaline composition from the Sukadana basalt province, Sebesi, Sebuku, Anak Krakatau and Panaitan islands [Nishimura et al., 1986].

4. CONCLUSIONS

There are two main findings in this study, namely:

a) the presence of Sukadana basalt on the surface is controlled by the northwest-southeast normal faults resulting from extensional deformation called gravitational subsidence. Therefore, the presence of Sukadana basalt on the surface is still indirectly influenced by the movement of the Sumatra fault;

b) based on the similarity of configurations of normal fault structures related to the Sumatra fault dynamics and of the Nishimura fracture with the Riedel shear model, it can be concluded that the Nishimura fracture is a sinistral strike-slip fault.

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6. CONTRIBUTION OF THE AUTHORS

All authors made an equivalent contribution to this article, read and approved the final manuscript.

7.DISCLOSURE

The authors declare that they have no conflicts of interest relevant to this manuscript.

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