コロンビアリバー玄武岩の枕状溶岩とパホイホイ溶岩

Pillow and pahoehoe lavas from the Columbia River Basalt

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コロンビアリバー玄武岩（ＣＲＢ）は世界で最もよく知られた大陸洪水玄武岩の一つであり，その300以上の溶岩流の多くが水中に浸入して，溶岩流下部はピローハイアロクラスタイト・コンプレックス（ＰＨＣ）を形成する．このような産状からＣＲＢは陸上のパホイホイと水中の枕状溶岩とを同一の溶岩の中で比較検討する好例となる．パホイホイローブの集合からなるコンパウンドパホイホイ溶岩が，ＰＨＣとその上位のコロネードの間に普遍的に見つかった．パホイホイと枕状溶岩の識別の基準が明らかになったので報告する．

Both pillow and pahoehoe lavas have been recognized to be formed by similar mechanisms, the former being formed subaqueously, and the latter subaerially. Even though the similarities between them have been discussed extensively, the differences between them have not yet been revealed enough, nor have criteria to tell apart one from other been established. Previous efforts to contrast pillow and pahoehoe lavas have mainly been based on data obtained from a wide range of localities. A clear contrast requires comparison of the two facies within individual lava flows so that variables including chemical composition and temperature of solidification are equivalent.

The Columbia River Basalt (CRB) is one of the world's most well-known continental flood basalts. It consists of more than 300 flows, many of which were emplaced in water and the lower part of the lava formed a pillow-hyaloclastite complex (PHC). Because of this manner of distribution, the CRB is expected to provide a good example for comparing the onland pahoehoe and subaqueous pillow lava facies within a single lava flow.

According to Swanson's (1967) idealized cross section of a CRB flow, the lower part consists of a PHC (Swanson called this part the pillow palagonite complex) and the upper part is a subaerial colonnade and entablature with more or less regularly developed cooling joints. The uppermost part of the PHC is named incipient pillows, because the pillow lobes are still attached to the flow base. The boundary zone between the PHC and the colonnade can be closely observed in some outcrops such as; Grande Ronde basalts in Moses Coulee; Ginkgo flow in Sand Hollow; Priest Rapids basalt east of Spokane, in Malden and in the Dalles. At these outcrops, a compound pahoehoe lava, that is an accumulation of pahoehoe flow lobes is consistently found. At least the upper part of Swanson's "incipient pillows" is not pillow but pahoehoe lava .

Pahoehoe lava tubes of small scale have been rarely reported from the CRB. In contrast, I will report many occurrences of pahoehoe lobes which have been misinterpreted as pillow lobes. Consequently, the criteria for distinguishing pahoehoe from pillow lobes must be discussed. The following six criteria are recognized.

(1) Pahoehoe lobes sometimes have a red coloration on the surface from oxidation. This does not always occur because the lobes are sometimes protected from contact with air by volcanic gases.

(2) As far as the CRB is concerned, pillow lobes are always surrounded by some hyaloclastic material. On the other hand, pahoehoe lobes are always close-packed. The surface marking the boundary between the presence and absence of hyaloclastite is always approximately horizontal, recording the ancient water level.

(3) Surfaces of pahoehoe lobes are not disrupted, instead they underwent plastic stretching, in contrast, surfaces of pillow lobes are usually broken indicating brittle effects during spreading.

(4) Glass rinds (often altered to yellowish palagonite) are much thicker in pillow lobes than in pahoehoe lobes.

(5) Pahoehoe lobes are always very vesicular especially at the margin, on the contrary, pillow lobes are vesiculated only in the upper several meters of the PHC. In every observed outcrop, the vesicularity of pillow lobes within their glass rinds is very high at the highest level of PHC but below that level the vesicularity decreases rapidly to nearly zero within only 10 meters depth. It is supposed that the separation of vesicles within tubes was very efficient and the magma lost vesicles rapidly.

(6) Glass rinds of pillow lobes are often multiply formed probably due to the intermittent supply of magma into the tube.