開水路ベッドフォーム形成条件の判別分析
Discriminant functions for formative conditions of bedforms in open-channel flows

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Fluvial bedforms such as ripples and plane bed are formed by interactions between flows and processes of sediment transport. Sedimentary structures formed by bedforms, hence, are clues to reconstruct paleo-flow conditions. For analysis of sedimentary structures, bedform existence diagrams have been proposed on the basis of laboratory and field observations, and have been widely used. To utilize the bedform existence diagrams for analysis of sedimentary structures, boundary lines of bedform stability regions are significant.
This study provides boundary surfaces of bedform stability regions defined as discriminant functions of dimensionless parameters. In previous studies, the lines were described manually without quantitative examination. Thus, previous studies that apply these diagrams to sedimentary structures lack sufficient statistic basis. To this end, this study obtained boundary lines as polynomial equations of dimensionless parameters.
First of all, we defined a new bedform existence diagram based on 3272 existing laboratory and field data. We used three parameters in dimensionless form. Some of diagrams in previous studies were not sufficient in the number or kinds of parameters. This study produces a new bedform stability diagram, which defines bedform stability regions by three dimensionless parameters: dimensionless grain size D_*, Shields mobility parameter τ_* and Froude number Fr.
On the basis of the diagram described above, discriminant functions are derived by following procedures. At first, a polynomial function with arbitrary coefficients which divides parametric space is supposed as a candidate of a discriminant function. Then, the ratio of data points of bedform experiments that was judged incorrectly by the polynomial function is calculated. At last, in order to minimize the ratio, coefficients of polynomial function is optimized.
The discriminant functions of bedforms obtained in this study can serve quantitative paleo-flow analysis of sedimentary structures. Their form is $Fr = f(D_*, \tau_*)$. This function can be recast in the form $U = f(D, h)$, where U = flow velocity; D = sediment particle size; h = flow depth. Thus, when we obtain the data of sediment particle size and flow depth from sedimentary structures, we can estimate paleo-flow velocity. The discriminant functions are useful and objective for estimation of paleo-flow conditions.

キーワード：ベッドフォーム、判別分析
Keywords: Bedform, Discriminant analysis