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Trans-Lithospheric Diapirism as a Possible Mechanism for Ophiolite Emplacement?

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Oceanic obduction and ophiolite emplacement are processes which result in positioning of more dense oceanic lithosphere on top of less dense continental crust. It is known that obduction is related to the closure of oceanic realms, however exact mechanisms that lead to the obduction of these ophiolite rocks, and more importantly, their permanent emplacement onto the continental crust is still controversial.

Although many mechanisms for ophiolite emplacement have been proposed, there have been substantial difficulties in modelling the ophiolite emplacement by means of numerical simulations. Creating physically viable simulations of the ophiolite emplacement is of paramount importance for better understanding of the process itself. There have been some notable successful attempts. For example, [1] succeeded in emplacing ophiolites by artificially reversing the velocity conditions once the ophiolite block is already obducted. More recently, [2] have shown that continental extrusion mechanism, which is a result of the activation of subducted continental crust at higher P-T conditions, can account for the emplacement of far-travelled ophiolites.

In this communication, we report interim results of our attempt to explain spontaneous emplacement of large ophiolite blocks by means of trans-lithospheric diapirism of continental crust. This phenomenon has recently been modelled [3] in the context of continental collision and the formation of the European Variscides. However, in this study, we produce a spontaneously induced intra-oceanic subduction. This model involves a retreating subduction with trench reaching the passive continental margin, leading to the continental subduction under very young oceanic lithosphere. Consequently, subducted crust is activated in deeper regions and forms a diapiric upward flow. This trans-lithospheric diapirism reaches the surface, thus separating the already obducted parts of the oceanic lithosphere from the rest of the oceanic domain, resulting in permanent ophiolite emplacement.

The presence of crustal rocks in such deep environments of ultra-high pressure certainly leads to their metamorphism. In the scope of our simulations we are monitoring the P-T paths of relevant crustal markers and propose rough estimates of the P-T conditions of metamorphic peak. For the calculations of the numerical simulations we utilize marker-in-cell method with conservative finite differences [4].

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