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# Software and Algorithms for Solving Computational Geodynamic Problems using Next Generation Hardware

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Numerical geodynamic modeling is typically based on solving a series of partial differential equations which describe the long-term behavior of the solid visco-elasto-brittle/plastic Earth as a highly viscous incompressible fluid with strongly variable non-Newtonian viscosity. Coding for solving geodynamic equations is catching up with the advance of modern high performance computing. In the past five years, newly developed many-core computing technology, including GPU (Graphics Processing Unit) and MIC (Many Integrated Core), has also been utilized for geodynamic modeling. However, the lack of easy-to-expand or easy-to-use geo-computing toolkits limits the high performance software catching up with the endless updating of high performance hardware. In this presentation, we will firstly show two examples of the implementation of solving geodynamic problems based on Stokes and continuity equations with strongly variable viscosity using many-core hardware, with a specific focus on the GPU. The first example is a geometric multi-grid (GMG) solver, which solves a synthetic sinking cube problem using a staggered grid finite difference discretization. The second example is a preconditioned minimal residual (MINRES) solver for incompressible Stokes flow problem with many viscous inclusions which is discretized using the finite element method. Through these two implementation examples, we will analyze the cost of coding and running advantages and disadvantages of the two kinds of coding methodologies, and in a hope to discuss a potential general coding flowchart for solving geodynamic equations using many-core devices. Finally, a software stack based many-core computing framework oriented to geodynamic modeling is proposed for the future.