lithosphere-mantle system, but are restricted to the upper 1000 km of the mantle and 50 million years of progressive time-evolution. While such models assume plates with simplified rheologies, uniform thickness and uniform density contrasts appropriate for mature oceanic lithosphere, their resultant 3D subduction dynamics are quite rich. The subducting plate and the sinking slab are coupled through a stress guide in the middle of the subducting plate (the strong core) as well as by virtue of poloidal and toroidal flows induced in the surrounding mantle. We will present the latest generation of these numerical models and provide an overview of how these models can be used to investigate the development of trench curvature, how the subduction rate is partitioned between forward plate advance and slab rollback, and how slab morphologies in the upper mantle are a product of these plate and trench motions.

As a result of numerous experiments, five distinct styles of subduction emerge as the entirety of possible ways a plate can subduct and these have been quantitatively described in a regime diagram with predictive capability. We propose that the variety of subduction regimes are generated primarily as a direct consequence of the presence of the modest barrier to flow into the lower mantle. The regime diagram can be understood from the competition between the weight of the slab and the strength of the plate, which are related to each other through an applied bending moment, and this competition produces a particular radius of curvature (for which we provide a simple scaling theory). Based on this regime diagram, and observations of the bending moment at several trenches, we propose that modern plate tectonics operates entirely within only 2 of these styles, but we speculate that other modes may have been the predominant style of subduction in the Precambrian.

Additionally, for the regime operating on present-day Earth (the Folding mode), we show that slab width (W) controls these modes and the partitioning of subduction between them. Using models from the Folding regime and a global subduction zone data set, we show that subducting plate velocity scales with $(W)^{2/3}$, whereas trench velocity scales with 1/W. These findings explain the Cenozoic slowdown of the Farallon plate and the decrease in subduction partitioning by its decreasing slab width. The change from Sevier-Laramide orogenesis the orogenesis to Basin and Range extension in North America is also explained by slab width; shortening occurred during wide-slab subduction and overriding-plate — driven trench retreat, whereas extension occurred during intermediate to narrow-slab subduction and slab-driven trench retreat.

Dynamic of gas hydrate deposits evolution under subaqueous conditions

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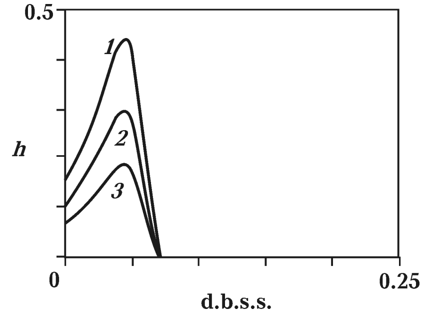
At present, more than 100 areas of gas hydrate manifestations in sediments have been revealed by various geophysical (mainly seismic) methods. Subsurface filtration is the most powerful process of gas and fluid transport into hydrate stability zone to form gas hydrate deposits in sediments [Davie, Buffet, 2002]. Pressures and temperatures favorable for the formation and stability of gas hydrates are widespread in seafloor structures, particularly, at continental margins, where accumulated sediments contain appreciable amounts of biological material, ensuring gas (mainly methane) influx into crustal fluids. Depths of hydrate stability interval and hydrate saturation are different in natural conditions. These differences were interpreted usually in the frame of thermal regime peculiarity. Peculiarity of sediment accumulation processes was not considered usually, but the sedimentation regime determined the evolution of porosity, permeability, fluid pressure and filtration rate in accumulating sediments [Suetnova, Vasseur, 2000]. Thus, to understand the mechanisms of accumulation and evolution of hydrate deposits in sediments during geological history it is necessary to study the complex geophysical process of porosity, filtration and hydrate accumulation evolution. The author's recent results of numerical modeling of gas hydrate accumulation in dependence on geophysical condition of sedimentation are presented below.

Methods and results. Gas and fluid filtration is determined by compaction during sediments pill growing, so, hydrate accumulation depends on sedimentation and compaction history of sediments. Interrelated processes of filtration and visco-elastic sediment compaction during sediment column growing are accounted for system of nonlinear differential equations supplemented by appropriate boundary conditions [Suetnova, Vasseur, 2000]. The system was reduced to a dimensionless form in order to reveal its characteristic scales [Barenblatt, 1982]. The dimensionality analysis of parameters and variables of the system reveals the compaction-related length L and time T scales characteristic of the problem considered [Suetnova, Vasseur, 2000]. Thus, the system in the dimensionless form with these scales contains the dimensionless characteristic similarity numbers $V=V_0/\ L/T$, and D=вз/T and, consequently, the depth and time distributions of the dimensionless porosity, the velocities of the sediment matrix and pore fluid, and the hydrate concentration, which are obtained as solutions of the system of equations, depend on these similarity numbers. Changes in the values of permeability, viscosity, and sedimentation rate alter the values of the characteristic similarity numbers of the compaction process, controlling the fluid flow in sediments [Suetnova, Vasseur, 2000]. Therefore, regular patterns of accumulation of gas hydrates in a growing layer of sediments depending on their physical and hydrodynamic properties and sedimentation rates can be determined as a function of the similarity numbers of the problem of visco-elastic compaction. To reveal the dynamic of hydrate accumulation the set of model calculation were performed using geophysical data on known hydrate regions. The influences of hydrate saturations on free pore volume and Damkohler number were taken into account in the calculations [Suetnova, 2007]. Results of the calculations show that hydrate accumulation essentially influences on pore fluid filtration process. Calculations of time-dependent evolution of gas hydrate deposits show that the rate of hydrate accumulation is higher in the case of developing overpressures compaction than in equilibrium compaction process; provided that real sedimentation rate and final sediment thickness and overburden pressure are equal in both case, but rheological and hydrodynamic property are different (Figure, Table).



Comparison of hydrate saturation versus distance from sediment surface, normalized to sediment final thickness, resulting after 2 m.years of sedimentation. Number of curve corresponds to the values of parameters, listed at table 1 at the same lines number.

№	t	V_0, m/s	m_0	η, Pa·s	μ, Pa·s	ρ_f, kg/m^3	ρ_s, kg/m^3	B, 1/Pa	k_0, m^2	V	D
1	7.7	10^{-10}	0.3	$5\cdot10^{20}$	$2.6\cdot10^{-3}$	$1.0\cdot10^{3}$	$2.65\cdot10^{3}$	10^{-9}	10^{-14}	0.06	0.06
2	0.77	10^{-10}	0.3	$5\cdot10^{21}$	$2.6\cdot10^{-3}$	$1.0\cdot10^{3}$	$2.65\cdot10^{3}$	10^{-8}	10^{-15}	0.6	0.6
3	0.77	10^{-10}	0.3	$5\cdot10^{21}$	$2.6\cdot10^{-3}$	$1.0\cdot10^{3}$	$2.65\cdot10^{3}$	10^{-9}	10^{-15}	0.6	0.06

Conclusions. The results of modeling interrelated processes of sediment compaction, filtration and hydrate accumulation during geological history of sediment pile forming gives the theoretical and numerical base to understand the dependence of hydrate accumulation dynamic on mechanical and hydrodynamic processes in sediments which determined it's dynamic during geological time.

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