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Primordial Soup: A Dance of Exchange Systems and Variables

Patrick Jasek, Herwig Turk

experiment
artist
oil engineer
primordial landscape
Hele-Shaw cell
geology

This art-enhanced scientific laboratory experience aimed to observe the interaction between Earth-abundant elements and the uniqueness of phenomenological, reconstructed archaic dynamics.

The project, titled *Primordial Soup: A Dance of Exchange Systems and Variables*, focuses on bringing back the primordial landscapes of the world that are now buried in the subsurface, with the ultimate goal of exploring crude oil dynamics and its early-stage movement in the presence of artificially recreated landscapes.

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For the recreation of the primordial landscape, various elements were selected. The presented results deliver unique insights into the intricate interplay of archaic systems and provide a new perspective on the origins of buried hydrocarbons.

Materials and Methods

Substance	Elements	Properties and abundance
Water	Hydrogen	Most abundant element in the universe
Water, Air	Oxygen	49.2% of the Earth's mass
Air	Nitrogen	78% of the atmosphere
Sodium chloride	Sodium	2.8% of the Earth's crust
Silicon oxide	Silicon	10% of the Earth's crust
Lugol's Iodine	Iodine	Heaviest of the halogens
Iron (III)- oxide	Iron	Most abundant by mass
Activated coal powder	Carbon	Fourth most abundant element in the universe

Table 1
List of elements and substances representing primordial constituents of prehistoric Earth.

Principle

The setup is inspired by the Hele-Shaw experiment, a flow visualization technique traditionally used in engineering and scientific research to examine flow and displacement characteristics in porous environments, e.g., rocks. It involves observing different flow configurations between two glass plates equipped with a mechanically controlled syringe injection system. However, we adopt an art-based approach that bridges the realms of art and engineering. By combining these disciplines, we aim to create an immersive experience that stimulates both intellectual and aesthetic engagement, providing a unique perspective on the interaction between matter and forces.

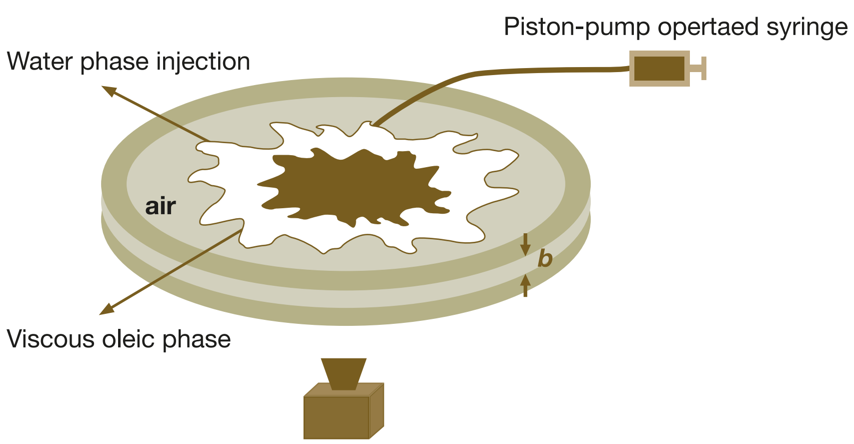

Figure 1
Schematic Hele-Shaw cell configuration.

Methodology

The Hele-Shaw cell (L: 42.4 x W: 32.3 x H: 0.5 cm), with an integrated high-resolution imaging setup with an underlying LED board, allowed for the visualization of primordial landscape dynamics and to capture crude oil's mobility. The interaction of various elements, under standard conditions, show advective and diffusive flow characteristics resembling natural processes. To realize the artistic vision we selected elements that address their abundance and high stability within the lithosphere.

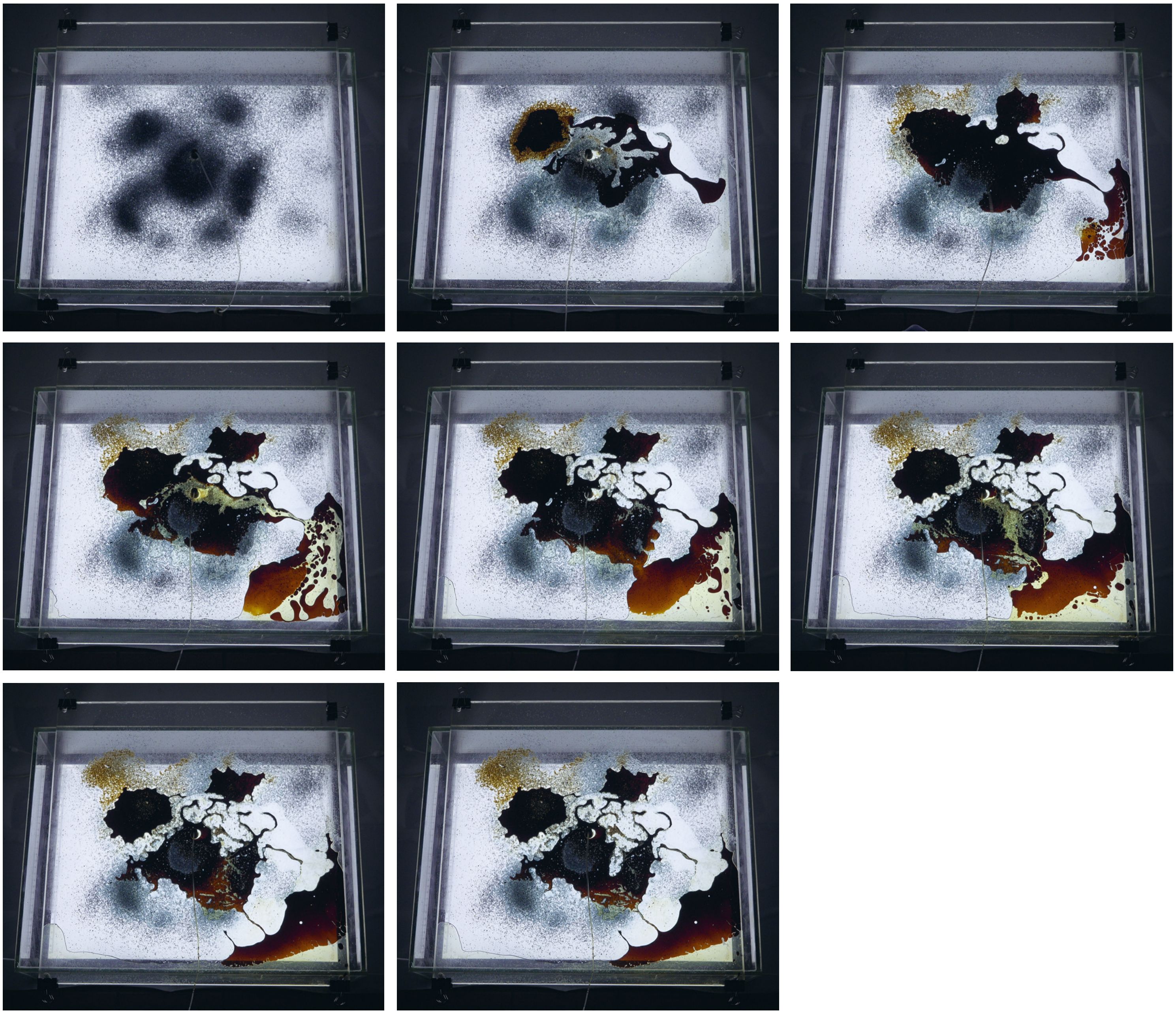

Figure 2
Time-lapse sequence of fluid displacement dynamics within a Hele-Shaw cell, capturing interactions of crude oil with selected lithospheric elements. The high-resolution imaging setup with LED backlighting reveals anisotropic flow patterns driven by advective and diffusive processes at different time-scales. It illustrates the evolution of landscape-like structures under controlled experimental conditions (4K video).

Procedure

1. Coating elements selection and application.
2. Injection fluid selection and rates.
3. Setup: Hele-Shaw cell with two glass plates.
4. Initialization: creating flow configurations to simulate the dynamics of archaic systems.
5. Data collection: observation and recording of flow patterns and matter interaction.
6. Analysis and interpretation of image data to describe system variables.

Remarks and Observations

To avoid the uncontrolled displacement of the glass plates caused by high pressure, the plates were fixed with clamps. A thin layer of grease was applied to the interior edges of the glass plates to avoid spill events. Experiments were not carried out under air-tight conditions.

During the investigation several fluid sequences where tested. The observed displacement and fluid propagation patterns resulted in unique schemes of an anisotropic nature (Figure 2). Localized homogeneities were the subject of detailed ROI (Region of Interest) analysis. Further, time resolved observation revealed significant changes in configuration at no-flow conditions (stopped injection). The rearrangement of the formed landscapes was triggered by the imbalance of system forces. Natural driving forces of capillarity and concentration, and gradient-driven diffusivity, dominated the system. Significant differences, controlling the sensitivity of variations with time, were subject of further analysis and were predominantly a function of drag forces and selected fluid viscosity.

Results and Discussion

The experiment explores the implications of the dynamics and their connection to the early stages of hydrocarbon formation below the surface. It examines the interplay between solid, liquid, and gaseous substances resulting from forced imbalance and the equilibration-driven process post injection. Finally, the rearrangement of solids during fluid injection unravels mechanisms relevant to river systems, meanders, sliding slopes, and other depositional environments. The aesthetically appealing forms are created by the substances, their interactions, and exchange systems. The aesthetic configurations that are formed are elemental and structurally connected to images of geodynamics. What is lost in the individual images is the speed of propagation, and thus resistance, of fluids to flow. The movement is not continuous but repeatedly delayed, jammed, and recurrently sudden. This missing time variable can be compared with the lack of human perception of the change in landscapes which happens constantly at geological time scales. Through this physically well-described technique, we explored the temporal aspects of beginnings in a science and art-fused manner of “tempus initiis,” or time of beginnings. The recreation and examination of subsurface mass movement at observable time scales under controlled laboratory conditions enabled us to unravel the intricate processes that shaped archaic landscapes and shed light on their uniqueness.

These experiments provide an illustrative view of the complex and fascinating processes within the Primordial Soup, shedding light on the underlying physical concepts. By using crude oil as a substance, the experiments offer a new perspective on the relevance of hydrocarbons and their impact on Earth‘s history.