

РОМАНСЬКІ ТА ГЕРМАНСЬКІ МОВИ

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FROM ROCKS TO ROADS: THE ROLE OF TRANSPORT METAPHOR IN CONCEPTUALISING GEOLOGICAL PHENOMENA

This article provides a cognitive-linguistic analysis of the transport metaphor in English geological terminology. The theoretical basis of the study is the concept of conceptual metaphor developed by G. Lakoff and M. Johnson and the methodology of metaphorical modelling by A. P. Chudinov. The relevance of this work lies in the growing interest in the cognitive mechanisms responsible for the formation of specialised knowledge in the natural sciences. The transport metaphor is interpreted as a system of correspondences, in which the sphere of 'transport' serves as a source of understanding for geological objects and processes. The article identifies and classifies terms with transport motivation and reconstructs the structure of the model 'GEOLOGICAL OBJECTS AND PROCESSES ARE TRANSPORT'. It has been established that this model is built on the frame-slot principle and includes two frames – 'Means of Transport' and 'Machine Components' – as well as three slots – 'Transport Movement', 'Marine Means of Transport' and 'Land Transport'. The internal structure of each slot is described and the general mechanisms of metaphorical transfer are identified.

The study demonstrates that metaphorical names conceptualise geological phenomena, such as dynamic tectonic processes, sediment transport, glacial and volcanic formations, underwater relief, and minerals, using images of trains, submarines, ships, and mechanical parts. The cognitive basis for such metaphorical transfer lies mainly in the similarity of movement, spatial configuration, shape, and external features, while functional aspects are of lesser importance. Contrastive analysis has revealed both universal and language-specific features in the use of transport metaphors. The results confirm the systemic nature of metaphor and its significant role in the cognitive organisation of geological knowledge.

This article revealed the key cognitive role of metaphors in structuring geological knowledge, improving terminological clarity and professional communication. This work demonstrates the importance of metaphorical analysis for a better understanding of scientific discourse and encourages the application of cognitive metaphor theory in the natural sciences.

Keywords: *metaphorical model, frame, slot, terminology, geology, transport-based metaphor.*

Statement of the problem. In modern cognitive linguistics, metaphor is understood as a universal cognitive mechanism that plays a key role in the formation of scientific concepts, particularly in fields such as geology and engineering. It helps to grasp abstract, directly invisible, or wildly complex processes by linking them to things we already know. [8, pp. 244–246; 7, pp. 4–7].

In geology, metaphor has particular cognitive significance, since its objects – geological structures, tectonic movements, and deep-earth processes – are

large-scale, dynamic, and hidden from direct observation. As P. Faber notes, the terminological systems of the Earth sciences actively use metaphorical transfer to verbalise the spatial organisation and dynamics of natural processes [3, pp. 35–38]. Such terms perform not only a nominative but also a cognitive function, contributing to the systematisation of specialised knowledge and effective professional communication [10, pp. 59–62].

Contemporary geological discourse reflects the rapid development of the Earth sciences through the



constant expansion and complexity of the terminological system, which ensures accurate professional communication and, at the same time, represents ways of conceptualising geological knowledge. An analysis of English-language geological terminology reveals a large corpus of metaphorical units – over 1,175 terms – indicating the systemic rather than peripheral nature of metaphor in this field [5]. Thus, metaphor functions as a basic strategy for structuring and sharing specialised meaning, which requires its comprehensive terminological and cognitive-linguistic analysis.

Analysis of recent research and publications.

The phenomenon of metaphor and its role in professional terminology have been thoroughly researched in both domestic and foreign linguistics. Significant contributions to the understanding of metaphor from a cognitive-linguistic perspective have been made by N. D. Arutiunov, O. S. Kubriakova, V. A. Maslova, V. M. Telia, M. M. Volodina, D. M. Shmelev, as well as J. Lakoff and M. Johnson, who consider metaphor to be a universal mechanism for conceptualising and structuring knowledge. Within these approaches, metaphor is interpreted not as a purely stylistic device but as a fundamental cognitive tool that enables understanding of abstract and complex phenomena through more concrete domains of experience [8].

Numerous studies have explored the processes of metaphorisation within professional terminology systems across various fields. In particular, metaphorical modelling has been studied in economic and political discourse (O. P. Vynnyk, A. P. Chudinov), in oil and gas engineering (O. O. Yefremov), and in geodesy (Yu. I. Grybinyk). At the same time, modern interdisciplinary studies show that metaphor plays a key role not only in the humanities but also in the natural and technical sciences. For example, a large-scale empirical study of academic texts, covering more than 40,000 scientific articles, showed that lexical metaphors are systematically used across all scientific disciplines, including physics, biology, and engineering, although their frequency and typology vary by subject area [9].

For a long time, research on geological terminology has focused primarily on its structural, semantic, word-formation, and translation characteristics across languages. The cognitive mechanisms of meaning formation and conceptualisation of geological processes have remained secondary. This approach contrasts with the general trend in the natural sciences, where metaphor is seen as a key cognitive “anchor” that provides a framework for understanding large-scale, dynamic, or directly unobservable phenomena. In physics and biology, for example, metaphorical

models of motion, interaction, and spatial organisation serve as a bridge between sensory experience and abstract theoretical constructs, greatly facilitating both scientific thinking and professional communication [1].

In this context, geology emerges as a discipline with particularly high metaphorical potential. This discipline concerns processes occurring deep within Earth’s crust that cannot be directly observed. That is why geological metaphors – especially those based on models of movement, transfer, and interaction – play a central role in the conceptualisation of geological objects and processes.

The **scientific novelty** of this study lies in the systematic identification and frame-slot modelling of transport-based metaphors in English geological terminology, which has not previously been systematically modelled within cognitive metaphor theory using frame-slot analysis.

Task statement. The **purpose** of the article is to analyse transport metaphors as a means of conceptualising geological objects, processes, and phenomena in English geological terminology. The **object** of study is transport-based metaphorical terms in English geological terminology. The **subject** of study is the metaphorical model “GEOLOGICAL OBJECTS AND PROCESSES ARE TRANSPORT”.

The **objectives** of the article include the identification and classification of transport-based metaphorical terms within the model “GEOLOGICAL OBJECTS AND PROCESSES ARE TRANSPORT,” as well as the examination of these terms according to their frame-slot structure.

Research Methodology. The study is based on the principles of cognitive linguistics and draws on the theory of conceptual metaphor developed by J. Lakoff and M. Johnson [8, pp. 3–6; 25–32], as well as on the methodology of metaphorical modelling proposed by A. P. Chudinov [2]. Within the cognitive approach, metaphor is viewed as a mechanism of conceptualisation, through which knowledge from a more concrete and empirically accessible source domain is systematically projected onto a more abstract or directly unobservable target domain. In a conceptual metaphor, the target domain A is comprehended through a source domain B. This comprehension is based on a set of mappings between elements of A and elements of B. To know a conceptual metaphor is to know this set of mappings [6, p. 29].

To analyse the internal structure of metaphorical transfer in specialised language, the study uses the method of metaphorical modelling, which allows metaphorical terms to be systematised into coher-

ent conceptual models. Productive metaphorical models are analysed using frame-slot organisation, which provides a structured representation of domain knowledge. A frame is considered a cognitive unit that organises knowledge around a specific concept and contains information about typical situations, participants and the relationships between them. According to C. J. Fillmore's definition, a frame is "a system of concepts related to each other in such a way that understanding one of them implies understanding the entire structure to which it belongs" [4, pp. 111–114].

Slots function as components of a frame and represent individual aspects, properties, or roles within a conceptual structure. In metaphorical modelling, slot analysis enables us to identify recurring patterns of metaphorical transfer and to distinguish among types of cognitive motivation, such as similarity in form, movement, spatial configuration, or external features. According to A. P. Chudinov's methodology, the identification of frames and slots, allows us to consider a metaphor not as a set of isolated lexical units, but as an ordered system that reflects the cognitive organisation of specialised knowledge [2].

Contrastive analysis techniques were used to investigate how transport metaphors are represented interlingually in English and Ukrainian geological terminology.

The study's empirical material comprises metaphorical terms selected from contemporary English-language explanatory and encyclopedic geological dictionaries. The analysis was carried out in stages: identification of metaphorical terms, determination of their source and target domains, classification within the metaphorical model "GEOLOGICAL OBJECTS AND PROCESSES ARE TRANSPORT", and interpretation of their cognitive motivation, taking into account the frame-slot structure. This methodology ensures the systematicity and reproducibility of the analysis of transport metaphors in English geological terminology and allows us to reveal their role in the conceptual organisation of geological knowledge.

Outline of the main material of the study. Contemporary English-language specialised geological terminology demonstrates a wide range of metaphorical sources. Images of everyday objects are mapped onto geological objects and processes. One of the most productive source domains is **TRANSPORT**, which provides vivid and cognitively accessible images for conceptualising geological objects and processes.

In this context, transport serves as the source domain that motivates the metaphorical model "GEOLOGICAL OBJECTS AND PROCESSES ARE TRANSPORT", which accounts for 3.1% of the

total metaphorical sample, and is structured by two frames: "Means of Transport" and "Machine Components".

The frame "Means of Transport" represents 94.4% of the terms within this metaphorical model. It includes the names of geological objects and processes metaphorically conceptualised as water- and land-based vehicles. This frame is divided into three slots: "Transport Movement" (e.g., *shipping ore*, *tectonic transport*, *traffic pan*), "Sea Vehicles" (e.g., *boat channel*, *submarine cave*, *canoe fold*), and "Overland Transport" (e.g., *oil train*, *rock train*).

The slot "Transport Movement" illustrates the dynamics, spatial displacement, and, in some cases, the configurational properties of geological objects, processes, and atmospheric phenomena. Within this slot, functional movement, particularly fluid flow and mass displacement, is conceptualised using the transport metaphor. The term *transport* occurs in metaphorical terminological combinations such as *mass transport* induced by orbital wave motion (the quantity of water crossing a one-meter-wide vertical plane perpendicular to the direction of motion and extending from the surface to a given depth), *sediment transport* by natural agents (the movement and removal of sediment primarily by natural forces), and *tectonic transport* (a deformation plane characterized by monoclinic symmetry).

Mineral characteristics are often conceptualised through the transport domain, where movement-related vehicle attributes are mapped onto mineral quality and economic sustainability. For example, the term «*shipping ore*» denotes *ore of such quality that its value exceeds the costs of transportation and treatment, thereby enabling direct market entry*.

The slot "Sea Vehicles" is formed by lexical items from the source domain "Water Vehicles," particularly submarine (literally, "a specialised watercraft capable of underwater operation"), which are primarily mapped metaphorically into geological terminology onto the locations of geological objects. This mapping is clear in terms such as *submarine canyon* (a steep-sided, V-shaped valley on the seafloor extending from the continental shelf down the continental slope and resembling a fluvially carved terrestrial canyon), *submarine volcano* (a volcano situated on the ocean floor, typically basaltic), and *submarine spring* (a substantial offshore discharge of freshwater, often associated with coastal karst systems or lava tubes). In addition, the same source-domain terminology denotes sites of geological processes, such as *submarine mining* and *submarine weathering*, the latter referring to the chemical and mineralogical transformation of sedi-

ments resulting from seawater-sediment interaction under conditions of minimal sedimentation.

Within the slot “**Overland Transport**”, geological objects are metaphorically conceptualised as a train. In this metaphorical mapping, the linear arrangement of carriages along tracks is projected onto the configuration of ice masses, glacial deposits, and relief forms. Accordingly, the longitudinal organization of trains motivates terms such as *train*, referring to long, narrow belts of glacial deposits; *boulder train*, denoting a series of glacial erratics derived from a common bedrock source and distributed across the landscape in a fan-shaped pattern with the apex at the source and widening in the direction of glacier movement; and *valley train*, a narrow, elongated body of outwash deposits laid down by meltwater beyond the terminal moraine or the margin of an active glacier, typically confined between valley walls.

The frame “**Machine Components**” accounts for 5.6% of the terms within the metaphorical model. It includes lexemes denoting components of transport machinery that are metaphorically transferred to minerals based on associative similarity in shape rather than function. Thus, the circular form of a wheel motivates mineral nominations such as *cogwheel ore* (lead-bearing dull ore, i.e., bournite, occurring in wheel-shaped twin crystals) and *wheel ore* (bournite crystallising in wheel-shaped twin formations). Form dominates function precisely because external, observable properties are more accessible to cognitive processing and verbalisation than hidden functional characteristics. This is consistent with recent studies showing that the recognition of metaphorical structures depends on the ability to model an object’s sensory and visual aspects [9].

A contrastive analysis of the translation of transport metaphors shows that, in many cases, metaphorical structures are preserved across languages, indicating the universality of certain cognitive models. For example, the English lexemes submarine canyon and submarine volcano correspond to the Ukrainian calques *підводний каньйон* and *підводний вулкан*, in which both the metaphorical image and the trans-

fer structure are preserved. This confirms that certain conceptual maps have interlingual representation [9].

However, in some cases, the adaptation of the metaphorical source in the Ukrainian translation shows language-specific differences: the term *boulder train*, which in English is based on the transport metaphor of a train, is translated as *валунний шлейф* (boulder trail), where the metaphorical model shifts to a natural spatial metaphor. This indicates that, in translation, metaphorical motivation can vary depending on the traditions and cognitive patterns of the target culture [9].

The productivity of transport metaphors in English geological terminology can be explained by their strong cognitive motivation. Transport provides a familiar experiential domain associated with movement, direction, linearity, containment, and spatial organisation – features that are central to geological processes and structures. By mapping these features onto geological phenomena, specialists achieve conceptual clarity and terminological efficiency.

Conclusions. The study of English-language geological terminology has shown that metaphors borrowed from the field of transportation are a key tool for organizing geological knowledge. Thanks to these metaphors, complex phenomena that are invisible to direct observation, such including tectonic plate movements, glacier formation as well as volcanic processes, submarine landscapes and mineral characteristics, become more understandable and visualizable. The study found that the model “GEOLOGICAL OBJECTS AND PROCESSES ARE TRANSPORT” has a clear structure that provides consistency and cognitive integrity in depicting real geologic processes. A comparative analysis of English and Ukrainian terms demonstrated both the universality of cognitive approaches and specific linguistic adaptations. The practical significance of the work consists in its application in the educational process, translation activities, the creation of popular science texts and dictionaries, as well as in further cognitive-linguistic research. As a **perspective** for further research, we see the study of other metaphorical source domains in geology and compare metaphorical patterns across languages and scientific disciplines.

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Галай Т.М. ВІД ГІРСЬКИХ ПОРІД ДО ДОРІГ: РОЛЬ ТРАНСПОРТНИХ МЕТАФОР У КОНЦЕПТУАЛІЗАЦІЇ ГЕОЛОГІЧНИХ ЯВИЩ

У цій статті проводиться когнітивно-лінгвістичний аналіз транспортної метафоричної моделі, що використовується в англійській геологічній термінології. Теоретичною базою дослідження слугують концепція концептуальної метафори Дж. Лакоффа та М. Джонсона та методологія метафоричного моделювання А. П. Чудінова. Актуальність роботи полягає у зростанні інтересу до когнітивних механізмів, які відповідають за формування спеціалізованого знання в природничих науках. Транспортна метафора трактується як система відповідностей, де сфера «транспорт» слугує джерелом для розуміння геологічних об'єктів та процесів. У статті було ідентифіковано та класифіковано терміни, що мають транспортну мотивацію, та реконструйовано структуру моделі «ГЕОЛОГІЧНІ ОБ'ЄКТИ ТА ПРОЦЕСИ – ЦЕ ТРАНСПОРТ». Встановлено, що ця модель побудована за фреймово-словим принципом і включає два фрейми - «Засоби транспорту» та «Складові машин», а також три слоти «Рух транспорту», «Морські засоби пересування» та «Наземний транспорт». Описано внутрішню структуру кожного слоту та визначено загальні механізми метафоричного перенесення.

Дослідження демонструє, що метафоричні найменування концептуалізують такі геологічні явища, як динамічні тектонічні процеси, переміщення осаду, льодовикові та вулканічні утворення, підводний рельєф та мінерали, використовуючи образи поїздів, субмарин, кораблів та деталей механізмів. Когнітивна основа такого метафоричного перенесення полягає переважно у схожості руху, просторової конфігурації, форми та зовнішніх ознак, тоді як функціональні аспекти мають менше значення. Застосування контрастивного аналізу дозволило виявити як універсальні, так і мовно-специфічні особливості вживання транспортних метафор. Отримані результати підтверджують системний характер метафори та її значну роль у когнітивній організації геологічних знань.

Дослідження виявило ключову когнітивну роль метафор у структуруванні геологічних знань, покращуючи термінологічну ясність та професійне спілкування. Ця робота демонструє важливість метафоричного аналізу для кращого розуміння наукового дискурсу та заохочує застосування когнітивної теорії метафор у природничих науках.

Ключові слова: метафорична модель, термінологія, фрейм, слот, транспортна метафора, геологія.

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