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A Study On The Translation Of Geological Scientific English

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Abstract:
Background: *As a subfield of scientific and technological English, geological scientific English integrates linguistic expression with geological expertise, yet it remains marginalized in China's translation studies. Travertine, a unique continental carbonate sediment widely deposited globally, forms iconic natural landscapes (e.g., China's Huanglong-Jiuzhaigou Scenic Area), making its research critical for international academic exchange. However, translation studies on travertine-related geological texts are particularly scarce.*
Materials and Methods: *Guided by Catford's Translation Shift Theory, this study explores Chinese-English translation strategies for travertine literature. Catford's theory, rooted in Halliday's systemic grammar, classifies translation shifts into level shifts and category shifts (structural, class, unit, and intra-system shifts), providing a linguistic framework to address English-Chinese linguistic disparities.*
Results: *Case analyses reveal that level shifts convert English grammatical features (tense, voice, number) into Chinese lexical markers (e.g., "已" for present perfect tense), while category shifts adapt English's static, noun-centric structures to Chinese's dynamic, verb-driven syntax through structural (passive-to-active), class (nominalization-to-verbalization), and unit (phrase-to-sentence) shifts. These shifts ensure functional equivalence, balancing scientific accuracy and target-language naturalness.*
Conclusion: *Catford's Translation Shift Theory offers direct guidance for geological English translation by clarifying shifts at lexical, phrasal, and sentential levels. While validated in travertine texts, its limitations (e.g., limited universality across language pairs) call for further research in broader geological subfields.*
Key Words: *Catford's Translation Shift Theory; geological scientific English; travertine; translation strategies; functional equivalence*

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I. Introduction

Geological scientific English, as a core branch of scientific and technological English, serves as an irreplaceable medium for international academic exchange in geoscience, seamlessly integrating rigorous linguistic expression with specialized geological knowledge. In an era defined by global collaboration in earth science research—encompassing continental sedimentation studies, paleoclimatic reconstruction, and geological heritage conservation—accurate translation of geological texts is critical for sharing research methodologies, standardizing technical terminologies, and promoting cross-border knowledge dissemination. It acts as a bridge that connects researchers worldwide, ensuring that breakthroughs in understanding earth processes, mineral formations, and environmental changes are accessible across linguistic boundaries (Li & Wang, 2020). However, despite its pivotal role, geological English translation remains a marginalized field in China's translation studies, with limited systematic research exploring its unique linguistic features and targeted translation strategies. This gap undermines the effectiveness of international academic communication in geoscience, particularly for specialized subfields.

This research deficit is especially pronounced in the translation of travertine-related literature. Travertine (or tufa), a distinctive continental carbonate sediment widely distributed across diverse global landscapes, holds immense scientific and cultural value. Scientifically, it preserves key evidence of long-term hydrological processes, chemical equilibrium shifts, and climatic variations, offering insights into earth's environmental history. Culturally, it forms iconic natural landscapes that attract global attention. China's Huanglong-Jiuzhaigou Scenic Area, a world-renowned UNESCO World Heritage Site celebrated for its pristine travertine terraces, pools, and unique ecological systems, exemplifies the dual scientific and aesthetic significance of such formations (Zhang et al., 2018). Yet, translation studies focusing specifically on travertine geomorphology texts are scarce, creating barriers to effectively communicating China's significant research achievements in this specialized domain to the international community.

Against this backdrop, this study explores tailored translation strategies for travertine geomorphology texts through the theoretical framework of Catford's Translation Shift Theory. Developed by Catford (1965) and

rooted in Halliday's systemic grammar (1978), this theory provides a rigorous linguistic lens to analyze "translation shifts"—deliberate deviations from formal equivalence between source text (ST) and target text (TT) to achieve functional adequacy. These shifts are categorized into level shifts (transfers between linguistic levels like grammar and lexis) and category shifts (structural, class, unit, and intra-system adjustments), which are uniquely suited to address typological differences between languages.

English, characterized by hypotactic syntax (reliance on conjunctions for logical connections) and static nominalization (framing actions as nouns), contrasts sharply with Chinese, a paratactic language (relying on word order for coherence) reliant on dynamic verbal expression (Lian, 2010). By analyzing travertine-related case studies, this research examines how strategic translation shifts mediate these differences, aiming to validate the theory's applicability in geological translation and propose replicable strategies. Ultimately, this study seeks to enhance the accuracy and readability of travertine text translations, facilitating more effective international academic exchange in geoscience.

Theoretical framework

This study is grounded in Catford's Translation Shift Theory, a foundational framework in translation studies that systematically addresses linguistic disparities between source and target languages. Developed by John C. Catford, the theory draws heavily on Halliday's systemic grammar (1978), particularly its classification of language into hierarchical "levels" (phonology, grammar, lexis), to explain the mechanisms of translation shifts from a general linguistic perspective (Lin, 2009).

In his seminal work A Linguistic Theory of Translation, Catford (1965) defines "translation shifts" as deliberate departures from formal equivalence, where linguistic elements in the source text (ST) are not replicated identically in the target text (TT) but are adjusted to ensure functional adequacy. These shifts are categorized into two primary types: level shifts and category shifts.

Level shifts occur when a feature operating at one linguistic level in ST (e.g., grammatical inflections) is rendered at a different level in TT (e.g., lexical markers). Category shifts, by contrast, involve adjustments within the grammatical system, encompassing four subtypes: structural shifts (syntactic reconfiguration), class shifts (changes in grammatical class), unit shifts (rank adjustments between phrases, clauses, or sentences), and intra-system shifts (realignments within corresponding grammatical systems, though less applicable to English-Chinese translation due to systemic differences) (Catford, 1965). This framework provides a rigorous analytical tool for identifying and justifying translation strategies in technical texts.

Characteristics of geological scientific English

Geological technical English closely integrates English language skills with geological expertise. Texts in this field contain a large number of purely technical terms and semi-technical terms, characterized by strong academic nature and the exclusive use of specialized vocabulary. During the translation process, translators should ensure the standardized use of terms. For instance, "钙华" is translated as "travertine/tufa", "calcite" as "方解石" (calcite), and "carbonate" as "碳酸盐" (carbonate).Geological English contains a large number of professional terms and concepts, and these terms and concepts may not have direct corresponding forms in different languages. In addition, geological English is characterized by complex syntactic structures and a large number of long sentences. Catford's Category Shift Theory, which includes structural shifts, class shifts, unit shifts, and intra-system shifts, provides geological English translators with a theoretical tool for handling complex syntactic structures. For example, structural shifts can help translators convert sentence structures between different languages to adapt to the expressive habits of the target language.

In terms of the lexical composition of English technical terms, semi-technical words and some general words are mostly derived from common English vocabulary. When these common words are adopted in a specific professional and technical field, they are given new meanings while still maintaining a close connection with their basic meanings—a phenomenon known as the "specialization of common words". Such words are characterized by polysemy: they have fixed meanings when collocated with different words and carry professional connotations in different specialized fields (Gu, 2012)

In addition, in syntactic level, it is charaterized by complex structures of prevalent use of long sentences, nominalizations, and passive voice to convey objective, dense information (Qin, 2019). For example, experimental procedures often employ passive voice to emphasize actions over agents (Newmark, 1988). Additionally, reliance on conjunctions and prepositions to explicitize logical relationships, contrasting with Chinese's paratactic preference for implicit coherence (Lian, 2010).

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II. Case Study Discussion

Geological technical English is a highly specialized genre that synthesizes linguistic precision with domain-specific expertise, posing unique challenges for translation. A defining feature of such texts is the prevalence of purely technical terms and semi-technical terms, which form the core of geological discourse. Purely technical terms, such as "travertine/tufa" (钙华), "calcite" (方解石), and "carbonate" (碳酸盐), refer

exclusively to geological concepts and require strict standardization to avoid ambiguity (Liu, 2015). Any inconsistency in their translation could distort scientific meanings, undermining the accuracy of academic communication.

Equally critical are semi-technical terms, derived from common vocabulary but repurposed with specialized meanings in geological contexts (Gu, 2012). For example, “deposition” shifts from its general meaning of “placement” to denote “the accumulation of sediments,” while “gradient” refers specifically to “slope steepness” in geological descriptions. These terms rely heavily on contextual and collocational cues for disambiguation, demanding translators to balance linguistic naturalness with technical fidelity.

In translation practice, maintaining terminological consistency is paramount. Translators must adhere to established conventions while adapting semi-technical terms to ensure they convey precise geological connotations in the target language. This dual focus on standardization and contextual adaptation lays the foundation for analyzing translation shifts in the following case studies.

Level Shift

Level shift refers to the phenomenon where "an element at a specific linguistic level in the source language has its equivalent at a different level in the target language". In other words, grammatical items in one language can be converted into lexical items in another language during translation, and vice versa (Lin, 2009). English and Chinese exhibit significant differences in grammatical devices and expressive conventions. The most prominent feature of English is its adoption of hypotaxis; it emphasizes consistency in grammatical categories such as "gender", "number", "case", "tense", "aspect", and "voice", prioritizes explicit cohesion, and restricts sentence structure through morphological inflections. By contrast, the most distinctive characteristic of Chinese lies in its use of parataxis. It focuses on implicit coherence, with grammatical meanings and logical connections subtly embedded within the text. Chinese prioritizes the sequence of events, chronological order, and semantic combination, while placing less emphasis on formal structure.

Here the translator will introduce the level shift phenomenon in geological technical English and examples will be analyzed respectively.

Example 1:

Source Text (ST): However, these travertine landscapes have been damaged to varying degrees. The travertine blackening is particularly prominent, but the relevant mechanism is still unclear.

Target Text (TT): 然而，这些钙华景观已遭受不同程度的损坏，其中以钙华黑化现象尤为突出，但相关的机制尚不明确。

The key linguistic feature in the first sentence lies in the structure "have been damaged", which concurrently carries two grammatical functions: Present Perfect Tense and Passive Voice. English expresses tense through explicit structural markers. In contrast, Chinese lacks inflectional changes to indicate tense and typically relies on lexical additions to convey the temporal relationship. To accurately transmit the present perfect tense, the translator added the Chinese adverb "已″ (already) in the target text. This lexical choice effectively replaces the English grammatical structure of "have been" and makes the temporal logic clear in Chinese, avoiding ambiguity about the timing of the event. In addition, English frequently uses the passive voice in scientific and technological texts to maintain objectivity, while Chinese prefers active voice constructions and often omits the passive marker "被″ to conform to its expressive habits. For "be damaged", the translator adopted lexical strategies to achieve an active conversion: the first was adding the verb "遭受″ (suffer) to shift the focus from the "passive state of being damaged" to the "active experience of damage" by the travertine landscapes., then the translator omitted the passive marker "被″ and directly constructed the sentence as "钙华景观已遭受损坏″ (travertine landscapes have suffered damage), which aligns with Chinese readers’ cognitive habits for academic expression. In this translation process, the grammatical meanings of "tense"and "voice" — which are explicitly marked at the grammatical level in English — were fully resolved in Chinese through the addition of "已″ and "遭受″. This practice directly embodies Catford’s Level Shift Theory: by converting grammatical structures of the source language into lexical choices of the target language, the translator ensured the accurate transmission of geological information while adhering to the linguistic norms of both languages.

Example 2:

ST: However, a number of features that have not yet been described give travertine uniqueness: (i) the effect of geomorphic change on flow regimes; (ii) differences in deposition controlled by different slopes; and (iii) the evolution of these steep channels or slope-like areas over time.

TT: 然而，一些尚未描述的特殊特征使这些钙华具有独特性：（i）地貌变化对流态的影响；（ii）不同坡度控制下的沉积差异；（iii）这些陡峭的河道或斜坡状区域随时间的演变。

"a number of" functions as a grammatical quantifier phrase in English. It is a fixed syntactic structure that modifies countable plural nouns (here, "features") to express an indefinite, moderate quantity (i.e., "several" or "some"). This quantificational meaning is encoded at the grammatical level, as it is tied to the phrase's syntactic role rather than the meaning of individual words. Since Chinese has no direct grammatical equivalent to "a number of," the translator adopted lexical compensation by using the Chinese adjective "一些" (some/several). This choice transforms the source language's(SL) grammatical quantificational structure into a target language(TL) lexical item, with the key advantage of semantic accuracy: "一些" precisely matches the indefinite quantity implied by "a number of," avoiding over-specification (e.g., "许多"/many) or under-specification (e.g., omitting the quantifier entirely) that could distort the original meaning.

English marks plural nouns through grammatical inflections (e.g., adding "-s" to "features," "regimes," "slopes"). In contrast, Chinese nouns have no plural inflections; thus, the translator must use lexical devices to signal plurality, ensuring the geological information (e.g., multiple features, various slopes) is not lost. Below (Table 1) is a breakdown of how plural nouns in the ST are handled in the TT:

SL Plural Noun	ST Context	TL Lexical Strategy	Rationale for Level Shift
features	"a number of features that have not yet been described"	"一些尚未描述的特殊特征" (added "一些" and "特殊")	"一些" reinforces the plural meaning implied by "a number of";"特殊" (special) is a lexical supplement that aligns with geological discourse (geological "features" are often "special" or "distinctive"), while indirectly emphasizing that multiple unique traits exist.
regimes	"the effect of geomorphic change on flow regimes"	"地貌变化对流态的影响" (contextual implication)	In geological contexts, "flow regimes" refers to multiple types of flow patterns (e.g., laminar flow, turbulent flow) influenced by geomorphic changes. The TL omits explicit lexical markers but relies on the logical relationship between "geomorphic change" (a macro factor) and "flow regimes" (micro outcomes) to implicitly signal plurality—readers in the geological field can infer "multiple flow regimes" without additional wording.
differences / slopes	"differences in deposition controlled by different slopes"	"不同坡度控制下的沉积差异" (added "不同")	"不同" (different) is a lexical adjective that directly encodes plurality: "不同坡度" (different slopes) clearly indicates multiple slope types, and "沉积差异" (depositional differences) implies comparisons across multiple deposition scenarios
channels / areas	"the evolution of these steep channels or slope-like areas"	"这些陡峭的河道或斜坡状区域随时间的演变" (added "这些")	"这些" (these) is a lexical demonstrative pronoun that explicitly refers to multiple entities. In Chinese, demonstratives like "这些" or "那些" are commonly used to mark plural nouns; "这些陡峭的河道" (these steep channels) and "这些…… 区域" (these...areas) directly correspond to the SL plurals "channels" and "areas", while enhancing the text's coherence by linking back to previously mentioned geological structures.

Table 1

Category Shift

In Catford's theoretical framework, "categories" encompass a broad range of grammatical elements, including parts of speech (e.g., nouns, verbs, adjectives) and various inflectional features such as gender, number, case, aspect, person, tense, voice, and modality. These categories are hierarchically classified: parts of speech are labeled "primary grammatical categories," while inflectional features like tense, modality, and case are defined as "subordinate grammatical categories." Additionally, syntactic roles such as subject, predicate, and object fall under the umbrella of "functional grammatical categories" (Catford, 1965).Based on these classifications, Catford subdivides category shifts into four distinct types: structural shifts (adjustments in syntactic structure), intra-word shifts (morphological changes within words), unit shifts (rank changes across grammatical levels, e.g., phrase to sentence), and intra-system shifts (realignments within corresponding grammatical systems).Notably, intra-system shifts— which involve substitutions within parallel grammatical systems (e.g., tense shifts between past and present perfect in English)—are less applicable to English-Chinese translation. This is due to the fundamental systemic differences between the two languages: English relies on inflections and explicit grammatical markers, while Chinese prioritizes lexical and contextual cues. Consequently, this study focuses on analyzing structural, intra-word, and unit shifts in geological text translation, excluding intra-system shifts from detailed case analysis.

Example 3:

ST: Tests were performed using a field emission scanning electron microscope (SEM) with an accelerating voltage of 5 KV to observe the microscopic morphology of travertine samples.

TT：使用加速电压为 5 KV 的场发射扫描电子显微镜（SEM 进行测试，以观察钙华样品的微观形态。

Catford (1965) defines structural shift as a deviation from formal grammatical correspondence between source and target languages, involving changes in syntactic structure to achieve functional equivalence. In the example "Tests were performed using a field emission scanning electron microscope (SEM)...", the English passive voice is a structural category that encodes objectivity through grammatical form. In Chinese, however, the absence of a systematic passive voice system necessitates a structural shift to the active voice, which aligns with Chinese's topic-prominent syntax(Wang, 2017). In English geological technical writing, the passive voice "Tests were performed" serves two critical functions tied to the genre's core demands:objectivity Emphasis and logical rigor. Chinese, by contrast, is an "active-voice-dominant" language. Its discourse norms prioritize concise, agent-oriented expression, and overusing passive constructions (e.g., "测试被进行″) would sound unnatural, rigid, and inconsistent with Chinese academic writing habits. To resolve this conflict, the translator adopted Structural Shift by converting the SL passive voice to a TL active structure.The passive-to-active conversion is not arbitrary but a necessity to achieve functional equivalence. It resolves the conflict between English's passive preference and Chinese's active preference, ensuring the TT is both "scientifically accurate" and "linguistically natural". For geological texts—where experimental procedures and instrument descriptions are frequent—this shift provides a replicable model: when translating English passive constructions describing experiments, use Chinese's "使用［仪器］进行［操作］″ structure to balance form and function.

Example 4:

ST: As the decrease in pCO2 causes the chemical equilibrium in the water to be altered, this leads to a gradual increase in SIc in the water along the process as well.

TT：由于pCO2降低会使得水中化学平衡遭到改变，从而导致滩流水中的方解石饱和指数（SIc 也沿流程逐渐升高。

Catford (1965) defines class shift as a change in the grammatical class of a word during translation, which occurs when the source language (SL) and target language (TL) lack direct grammatical equivalents. In Example 4, the source sentence exhibits two nominalizations: "decrease" and "increase," both functioning as nouns preceded by the definite article "the" and followed by the preposition "in." In contrast, the Chinese translation converts these nouns into verbs: "降低″ (decrease) and "升高″ (increase)(Qin, 2019). This divergence reflects a fundamental typological difference between English and Chinese. English, a static language, favors nominalization—using nouns to denote actions, processes, or states—to achieve objectivity and compactness. Nominalized structures like "the decrease in pCO " encapsulate actions within noun phrases, which are syntactically integrated through prepositional phrases. Chinese, a dynamic language, relies more on verbs to directly represent actions, making its syntax more reliant on verbal chains and sequential narration. The translator's decision to convert nouns to verbs is not arbitrary but a strategic adaptation to achieve functional equivalence across languages. By rendering "decrease" as "降低″ (verb), the Chinese text establishes a direct cause-effect sequence. In addition, the "verb + adverb" structure ("逐渐升高″) aligns with Chinese scientific writing norms, where processes are often described through dynamic verbs modified by adverbs of manner or degree. This avoids the stilted "translationese" of literal nominalization (e.g., "SIc 的逐渐增加″). By prioritizing functional equivalence over formal correspondence, the translator ensures that scientific accuracy is preserved, linguistic naturalness is achieved, preventing the TT from sounding unnatural to Chinese readers and genre consistency is upheld, as the active-verb structure aligns with Chinese scientific writing's preference for concise, process-oriented descriptions.

Example 5:

ST: The Ca2+ concentration fitted to the elevation had a poor correlation with an r of 0.34, while the hydraulic gradient fitted to the Ca2+ concentration with the addition of the velocity and flow distance parameters had a better correlation with an r as high as 0.92. The results indicate that the hydraulic gradient of low-gradient slopes is positively correlated with travertine deposition.

TT: Ca2+与海拔拟合的r为0.34，相关性较差；而加入速度和流程参数后的水力坡度与Ca2+拟合，r高达0.92，有更好的相关性，结果表明滩流的水力坡度与钙华沉积成正相关。

Unit shift occurs when a meaning expressed at one rank in SL is rendered at a higher or lower rank in TL, driven by structural disparities between languages. In technical texts, this shift ensures that information is conveyed naturally while preserving accuracy. In the English source text, two prepositional phrases"with an r of 0.34" and "with an r as high as 0.92" modify the noun "correlation" by providing specific statistical data (the correlation coefficient r). In English technical writing, prepositional phrases are widely used for concise modification, leveraging the language's "hypotactic" (formally connected) nature to pack additional information into compact structures(Chen, 2020). In the Chinese target text, these phrases are converted into independent sentences (at the sentence rank in Chinese grammar):"r 为 0.34，相关性较差″ (literally: "r is 0.34, and the correlation is poor")"r 高达 0.92，有更好的相关性″ (literally: "r is as high as 0.92, with a better

correlation"). This shift is not arbitrary but a response to Chinese's grammatical norms. English uses conjunctions ("while," "and") and complex sentences to integrate related information into a single grammatical unit, maintaining formal cohesion. Chinese relies on sentence groups to express complex logic, using short, independent sentences linked by semantic flow.The unit shifts in Example 5 serve three critical functions. The first is preserving information integrity. By converting phrases to sentences, the specific r values and their implications (poor vs. better correlation) are not compressed or lost, ensuring the scientific data remains precise. The second is enhancing readability. Elevating sentences to a sentence group adapts to Chinese's preference for flowing, logic-driven narration over complex syntactic structures, preventing the "translationese" that would result from rigidly following English sentence boundaries. Last but not least, aligning with genre norms: In geological and environmental technical texts, where statistical results and causal inferences are central, unit shift ensures that data (e.g., r values) and interpretations (e.g., "positively correlated") are presented in a way that meets Chinese academic readers' expectations for clarity and coherence.

III. Conclusion

This research underscores the pivotal role of Catford's Translation Shift Theory in guiding geological scientific English translation, with particular relevance to travertine-related studies. By systematically implementing "level shifts" and "category shifts," translators effectively resolve structural mismatches between English's hypotactic, noun-centric syntax and Chinese's paratactic, verb-driven linguistic norms. In this study, level shifts facilitate the conversion of English grammatical devices—such as tense, voice, and number—into Chinese lexical elements, ensuring temporal sequence and logical coherence without relying on formal inflections. Meanwhile, category shifts adapt English's static, compact syntactic structures to Chinese's dynamic, linearly organized discourse patterns. Functional equivalence is achieved through these strategic shifts, which prioritize target-language conventions without sacrificing scientific precision. For instance, nominalized processes in English are transformed into verb-adverb phrases in Chinese, enhancing both interpretive clarity and stylistic naturalness. While centered on travertine geomorphology, these findings carry broader implications for technical translation, emphasizing the indispensable role of linguistic theory in bridging disciplinary and cultural communication gaps. Nevertheless, the study has limitations, including the underdeveloped application of intra-system shifts in English-Chinese translation and the need for validation across broader geological subfields such as mineralogy and tectonics (Qin, 2019). Future research directions could explore cross-linguistic shifts in multilingual geological discourse or refine translation strategies for emerging technical terminology, further enhancing the theory's practical utility in specialized academic communication.

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