

ISSN 2518-170X (Online)
ISSN 2224-5278 (Print)

ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫ

Satbayev University

Х А Б А Р Л А Р Ы

ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ
НАУК РЕСПУБЛИКИ
КАЗАХСТАН
Satbayev University

N E W S

OF THE ACADEMY OF SCIENCES
OF THE REPUBLIC OF
KAZAKHSTAN
Satbayev University

SERIES

OF GEOLOGY AND TECHNICAL SCIENCES

6 (456)

NOVEMBER – DECEMBER 2022

THE JOURNAL WAS FOUNDED IN 1940

PUBLISHED 6 TIMES A YEAR

ALMATY, NAS RK

NAS RK is pleased to announce that News of NAS RK. Series of geology and technical sciences scientific journal has been accepted for indexing in the Emerging Sources Citation Index, a new edition of Web of Science. Content in this index is under consideration by Clarivate Analytics to be accepted in the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index. The quality and depth of content Web of Science offers to researchers, authors, publishers, and institutions sets it apart from other research databases. The inclusion of News of NAS RK. Series of geology and technical sciences in the Emerging Sources Citation Index demonstrates our dedication to providing the most relevant and influential content of geology and engineering sciences to our community.

Қазақстан Республикасы Ұлттық ғылым академиясы «ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы» ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. Web of Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын ұсынады. ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді геология және техникалық ғылымдар бойынша контентке адалдығымызды білдіреді.

НАН РК сообщает, что научный журнал «Известия НАН РК. Серия геологии и технических наук» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Известия НАН РК. Серия геологии и технических наук в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному контенту по геологии и техническим наукам для нашего сообщества.

Бас редактор

ЖҰРЫНОВ Мұрат Жұрынұлы, химия ғылымдарының докторы, профессор, ҚР ҰҒА академигі, Қазақстан Республикасы Ұлттық Ғылым академиясының президенті, АҚ «Д.В. Сокольский атындағы отын, катализ және электрохимия институтының» бас директоры (Алматы, Қазақстан) **Н = 4**

Ғылыми хатшы

АБСАДЫКОВ Бахыт Нарикбайұлы, техника ғылымдарының докторы, профессор, ҚР ҰҒА жауапты хатшысы, А.Б. Бектұров атындағы химия ғылымдары институты (Алматы, Қазақстан) **Н = 5**

Редакциялық алқа:

ӘБСАМЕТОВ Мәліс Құдысұлы (бас редактордың орынбасары), геология-минералогия ғылымдарының докторы, профессор, ҚР ҰҒА академигі, «У.М. Ахмедсафина атындағы гидрогеология және геоэкология институтының» директоры (Алматы, Қазақстан) **Н = 2**

ЖОЛТАЕВ Герой Жолтайұлы (бас редактордың орынбасары), геология-минералогия ғылымдарының докторы, профессор, Қ.И. Сатпаев атындағы геология ғылымдары институтының директоры (Алматы, Қазақстан) **Н = 2**

СНОУ Дэниел, Ph.D, қауымдастырылған профессор, Небраска университетінің Су ғылымдары зертханасының директоры (Небраска штаты, АҚШ) **Н = 32**

ЗЕЛЬТМАН Реймар, Ph.D, табиғи тарих мұражайының Жер туралы ғылымдар бөлімінде петрология және пайдалы қазбалар кен орындары саласындағы зерттеулердің жетекшісі (Лондон, Англия) **Н = 37**

ПАНФИЛОВ Михаил Борисович, техника ғылымдарының докторы, Нанси университетінің профессоры (Нанси, Франция) **Н = 15**

ШЕН Пин, Ph.D, Қытай геологиялық қоғамының тау геологиясы комитеті директорының орынбасары, Американдық экономикалық геологтар қауымдастығының мүшесі (Пекин, Қытай) **Н = 25**

ФИШЕР Аксель, Ph.D, Дрезден техникалық университетінің қауымдастырылған профессоры (Дрезден, Берлин) **Н = 6**

КОНТОРОВИЧ Алексей Эмильевич, геология-минералогия ғылымдарының докторы, профессор, РҒА академигі, А.А. Трофимука атындағы мұнай-газ геологиясы және геофизика институты (Новосибирск, Ресей) **Н = 19**

АГАБЕКОВ Владимир Енокович, химия ғылымдарының докторы, Беларусь ҰҒА академигі, Жаңа материалдар химиясы институтының құрметті директоры (Минск, Беларусь) **Н = 13**

КАТАЛИН Стефан, Ph.D, Дрезден техникалық университетінің қауымдастырылған профессоры (Дрезден, Берлин) **Н = 20**

СЕЙТМҰРАТОВА Элеонора Юсуповна, геология-минералогия ғылымдарының докторы, профессор, ҚР ҰҒА корреспондент-мүшесі, Қ.И. Сатпаев атындағы Геология ғылымдары институты зертханасының меңгерушісі (Алматы, Қазақстан) **Н = 11**

САҒЫНТАЕВ Жанай, Ph.D, қауымдастырылған профессор, Назарбаев университеті (Нұр-Сұлтан, Қазақстан) **Н = 11**

ФРАТТИНИ Паоло, Ph.D, Бикокк Милан университеті қауымдастырылған профессоры (Милан, Италия) **Н = 28**

«ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы».

ISSN 2518-170X (Online),

ISSN 2224-5278 (Print)

Меншіктеуші: «Қазақстан Республикасының Ұлттық ғылым академиясы» РҚБ (Алматы қ.).

Қазақстан Республикасының Ақпарат және қоғамдық даму министрлігінің Ақпарат комитетінде 29.07.2020 ж. берілген № **KZ39VPY00025420** мерзімдік басылым тіркеуіне қойылу туралы куәлік.

Тақырыптық бағыты: *геология, мұнай және газды өңдеудің химиялық технологиялары, мұнай химиясы, металдарды алу және олардың қосындыларының технологиясы.*

Мерзімділігі: жылына 6 рет.

Тиражы: 300 дана.

Редакцияның мекен-жайы: 050010, Алматы қ., Шевченко көш., 28, 219 бөл., тел.: 272-13-19

<http://www.geolog-technical.kz/index.php/en/>

© Қазақстан Республикасының Ұлттық ғылым академиясы, 2022

Типографияның мекен-жайы: «Аруна» ЖК, Алматы қ., Мұратбаев көш., 75.

Главный редактор

ЖУРИНОВ Мурат Журинович, доктор химических наук, профессор, академик НАН РК, президент Национальной академии наук Республики Казахстан, генеральный директор АО «Институт топлива, катализа и электрохимии им. Д.В. Сокольского» (Алматы, Казахстан) **Н = 4**

Ученый секретарь

АБСАДЫКОВ Бахыт Нарикбаевич, доктор технических наук, профессор, ответственный секретарь НАН РК, Институт химических наук им. А.Б. Бектурова (Алматы, Казахстан) **Н = 5**

Редакционная коллегия:

АБСАМЕТОВ Малис Кудысович, (заместитель главного редактора), доктор геологоминералогических наук, профессор, академик НАН РК, директор Института гидрогеологии и геоэкологии им. У.М. Ахмедсафина (Алматы, Казахстан) **Н = 2**

ЖОЛТАЕВ Герой Жолтаевич, (заместитель главного редактора), доктор геологоминералогических наук, профессор, директор Института геологических наук им. К.И. Сатпаева (Алматы, Казахстан) **Н = 2**

СНОУ Дэниел, Ph.D, ассоциированный профессор, директор Лаборатории водных наук университета Небраски (штат Небраска, США) **Н = 32**

ЗЕЛЬТМАН Реймар, Ph.D, руководитель исследований в области петрологии и месторождений полезных ископаемых в Отделе наук о Земле Музея естественной истории (Лондон, Англия) **Н = 37**

ПАНФИЛОВ Михаил Борисович, доктор технических наук, профессор Университета Нанси (Нанси, Франция) **Н = 15**

ШЕН Пин, Ph.D, заместитель директора Комитета по горной геологии Китайского геологического общества, член Американской ассоциации экономических геологов (Пекин, Китай) **Н = 25**

ФИШЕР Аксель, ассоциированный профессор, Ph.D, технический университет Дрезден (Дрезден, Берлин) **Н = 6**

КОНТОРОВИЧ Алексей Эмильевич, доктор геолого-минералогических наук, профессор, академик РАН, Институт нефтегазовой геологии и геофизики им. А.А. Трофимука СО РАН (Новосибирск, Россия) **Н = 19**

АГАБЕКОВ Владимир Енокович, доктор химических наук, академик НАН Беларуси, почетный директор Института химии новых материалов (Минск, Беларусь) **Н = 13**

КАТАЛИН Стефан, Ph.D, ассоциированный профессор, Технический университет (Дрезден, Берлин) **Н = 20**

СЕЙТМУРАТОВА Элеонора Юсуповна, доктор геолого-минералогических наук, профессор, член-корреспондент НАН РК, заведующая лабораторией Института геологических наук им. К.И. Сатпаева (Алматы, Казахстан) **Н = 11**

САГИНТАЕВ Жанай, Ph.D, ассоциированный профессор, Назарбаев университет (Нурсултан, Казахстан) **Н = 11**

ФРАТТИНИ Паоло, Ph.D, ассоциированный профессор, Миланский университет Бикокк (Милан, Италия) **Н = 28**

«Известия НАН РК. Серия геологии и технических наук».

ISSN 2518-170X (Online),

ISSN 2224-5278 (Print)

Собственник: Республиканское общественное объединение «Национальная академия наук Республики Казахстан» (г. Алматы).

Свидетельство о постановке на учет периодического печатного издания в Комитете информации Министерства информации и общественного развития Республики Казахстан № **KZ39VPY00025420**, выданное 29.07.2020 г.

Тематическая направленность: *геология, химические технологии переработки нефти и газа, нефтехимия, технологии извлечения металлов и их соединений.*

Периодичность: 6 раз в год.

Тираж: 300 экземпляров.

Адрес редакции: 050010, г. Алматы, ул. Шевченко, 28, оф. 219, тел.: 272-13-19

<http://www.geolog-technical.kz/index.php/en/>

© Национальная академия наук Республики Казахстан, 2022

Адрес типографии: ИП «Аруна», г. Алматы, ул. Муратбаева, 75.

Editorial chief

ZHURINOV Murat Zhurinovich, doctor of chemistry, professor, academician of NAS RK, president of the National Academy of Sciences of the Republic of Kazakhstan, general director of JSC "Institute of fuel, catalysis and electrochemistry named after D.V. Sokolsky" (Almaty, Kazakhstan) **H = 4**

Scientific secretary

ABSADYKOV Bakhyt Narikbaevich, doctor of technical sciences, professor, executive secretary of NAS RK, Bekturov Institute of chemical sciences (Almaty, Kazakhstan) **H = 5**

Editorial board:

ABSAMETOV Malis Kudysovich, (deputy editor-in-chief), doctor of geological and mineralogical sciences, professor, academician of NAS RK, director of the Akhmedsafin Institute of hydrogeology and hydrophysics (Almaty, Kazakhstan) **H=2**

ZHOLTAEV Geroy Zholtaevich, (deputy editor-in-chief), doctor of geological and mineralogical sciences, professor, director of the institute of geological sciences named after K.I. Satpayev (Almaty, Kazakhstan) **H=2**

SNOW Daniel, Ph.D, associate professor, director of the laboratory of water sciences, Nebraska University (Nebraska, USA) **H = 32**

ZELTMAN Reymar, Ph.D, head of research department in petrology and mineral deposits in the Earth sciences section of the museum of natural history (London, England) **H = 37**

PANFILOV Mikhail Borisovich, doctor of technical sciences, professor at the Nancy University (Nancy, France) **H=15**

SHEN Ping, Ph.D, deputy director of the Committee for Mining geology of the China geological Society, Fellow of the American association of economic geologists (Beijing, China) **H = 25**

FISCHER Axel, Ph.D, associate professor, Dresden University of technology (Dresden, Germany) **H=6**

KONTOROVICH Aleksey Emilievich, doctor of geological and mineralogical sciences, professor, academician of RAS, Trofimuk Institute of petroleum geology and geophysics SB RAS (Novosibirsk, Russia) **H = 19**

AGABEKOV Vladimir Enokovich, doctor of chemistry, academician of NAS of Belarus, honorary director of the Institute of chemistry of new materials (Minsk, Belarus) **H = 13**

KATALIN Stephan, Ph.D, associate professor, Technical university (Dresden, Berlin) **H = 20**

SEITMURATOVA Eleonora Yusupovna, doctor of geological and mineralogical sciences, professor, corresponding member of NAS RK, head of the laboratory of the Institute of geological sciences named after K.I. Satpayev (Almaty, Kazakhstan) **H=11**

SAGINTAYEV Zhanay, Ph.D, associate professor, Nazarbayev University (Nursultan, Kazakhstan) **H = 11**

FRATTINI Paolo, Ph.D, associate professor, university of Milano-Bicocca (Milan, Italy) **H = 28**

News of the National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technology sciences.

ISSN 2518-170X (Online),

ISSN 2224-5278 (Print)

Owner: RPA «National Academy of Sciences of the Republic of Kazakhstan» (Almaty).

The certificate of registration of a periodical printed publication in the Committee of information of the Ministry of Information and Social Development of the Republic of Kazakhstan **No. KZ39VPY00025420**, issued 29.07.2020.

Thematic scope: *geology, chemical technologies for oil and gas processing, petrochemistry, technologies for extracting metals and their connections.*

Periodicity: 6 times a year.

Circulation: 300 copies.

Editorial address: 28, Shevchenko str., of. 219, Almaty, 050010, tel. 272-13-19

<http://www.geolog-technical.kz/index.php/en/>

© National Academy of Sciences of the Republic of Kazakhstan, 2022

Address of printing house: ST «Aruna», 75, Muratbayev str, Almaty.

NEWS of the National Academy of Sciences of the Republic of Kazakhstan

SERIES OF GEOLOGY AND TECHNICAL SCIENCES

ISSN 2224-5278

Volume 6, Number 456 (2022), 185-195

<https://doi.org/10.32014/2518-170X.248>

A.P. Permana^{1,3*}, S.S. Eraku², R. Hutagalung¹, D.R. Isa³

¹Geological Engineering Study Program, Earth Science and Technology Department,
Universitas Negeri Gorontalo, Gorontalo, Indonesia;

²Geography Education Study Program, Earth Science and Technology Department,
Universitas Negeri Gorontalo, Gorontalo, Indonesia;

³Faculty of Mathematics and Natural Science, Universitas Negeri Gorontalo,
Gorontalo, Indonesia.

E-mail: aang@ung.ac.id

**LIMESTONE FACIES AND DIAGENESIS ANALYSIS IN THE SOUTHERN
OF GORONTALO PROVINCE, INDONESIA**

Abstract. Strong tectonic effects have influenced the complexity of the geological conditions in the southern half of Gorontalo Province, Indonesia. As seen today, the raising of limestone into hills is one example. Furthermore, because it is located between the major volcanic and plutonic rocks, the distribution of limestone in the study area is quite distinctive. Most of the research related to limestone in the research area have only been conducted on a regional scale, therefore, a more in-depth analysis is required to gather the most up-to-date geological data. For this reason, this research aimed to look at the facies and diagenesis of limestones in the southern section of Indonesia's Gorontalo Province. Field surveys will be used to achieve the research objectives, including a megascopic study of limestone and petrographic analysis in the laboratory. The results revealed that Gorontalo Province's southern part's limestone facies are coralline floatstone. Based on the petrographic analysis, six different diagenesis processes occur in coralline floatstone. The six diagenesis processes include microbial micritization, initial calcite cementation, cementation, dissolution, neomorphism (inversion), and neomorphism (recrystallization). The research area's limestone diagenetic environment comprises three diagenesis environments: it begins with the diagenesis process in the marine phreatic zone, then turns into the meteoric phreatic zone, and ends with the diagenesis process in the meteoric vadose zone.

Key words: Diagenesis, Facies, Gorontalo, Limestone.

А.П. Пермана^{1,3*}, С.С. Эраку², Р. Хутагалунг¹, Д.Р. Иса³

¹Геологиялық инженерияны зерттеу бағдарламасы, Жер туралы ғылым және технология департаменті, Негери Горонтало университеті, Горонтало, Индонезия;

²География білімін зерттеу бағдарламасы, Жер туралы ғылым және технология департаменті, Негери, Горонтало университеті, Горонтало, Индонезия;

³Математика және жаратылыстану факультеті, Негери Горонтало университеті, Горонтало, Индонезия.
E-mail: aang@ung.ac.id

ИНДОНЕЗИЯ, ГОРОНТАЛО ПРАВИНЦИЯСЫНЫҢ ОҢТҮСТІГІНДЕГІ ЭКТАСТЫ ФАСИЯЛАР ЖӘНЕ ДИАГЕНЕЗІСТІ ТАЛДАУ

Аннотация. Күшті тектоникалық әсерлер Индонезияның Горонтало провинциясының оңтүстік жартысындағы геологиялық жағдайлардың күрделілігіне әсер етті. Оның бір мысалы эктастың төбеге көтерілуі. Олар жанартаулық және плутондық жыныстардың арасында орналасқандықтан, зерттелетін аймақтағы эктастың таралуы айтарлықтай ерекшеленеді. Зерттеу аймағындағы эктасқа қатысты зерттеулердің көпшілігі тек аймақтық ауқымда жүргізілді, сондықтан ең өзекті геологиялық деректерді жинау үшін тереңірек талдау қажет. Осы себепті бұл зерттеу Индонезияның Горонтало провинциясының оңтүстік бөлігіндегі эктастардың фациялары мен диагенезін зерттеуді мақсат етті. Зертханада эктастарды мегаскопиялық зерттеу және петрографиялық талдауды қоса алғанда, зерттеу мақсаттарына қол жеткізу үшін далалық зерттеулер қолданылады. Нәтижесінде Горонтало провинциясының оңтүстік бөлігіндегі эктас фациялары маржанды флотта екенін анықталды. Петрографиялық талдау негізінде кораллин флоатста алты түрлі диагенез процесі жүреді. Алты диагенез процестеріне микробтық микротизация, кальциттің бастапқы цементтелуі, еруі, инверсия және қайта кристалдану жатады. Зерттеу аймағының эктас диагенетикалық ортасы үш диагенез ортасынан тұрады: ол теңіз фреатикалық аймағында диагенез процесінен басталып, кейін метеорлық фреатикалық аймаққа айналады және метеорлық вадоза аймағында диагенез процесімен аяқталады.

Түйін сөздер: диагенез, фация, горонтало, эктас.

А.П. Пермана^{1,3*}, С.С. Эраку², Р. Хутагалунг¹, Д.Р. Иса³

¹Учебная программа по инженерной геологии, факультет наук о Земле и технологии, Университет Негери Горонтало, Горонтало, Индонезия;

²Учебная программа по географии, факультет наук о Земле и технологий, Университет Негери Горонтало, Горонтало, Индонезия;

³Факультет математики и естественных наук, Университет Негери Горонтало, Горонтало, Индонезия.
E-mail: aang@ung.ac.id

ИЗВЕСТНЯКОВЫЕ ФАЦИИ И ДИАГЕНЕЗИЧЕСКИЙ АНАЛИЗ НА ЮГЕ ПРОВИНЦИИ ГОРОНТАЛО, ИНДОНЕЗИЯ

Аннотация. Сильные тектонические эффекты повлияли на сложность геологических условий в южной половине провинции Горонтало, Индонезия. Как видно сегодня, поднятие известняка в холмы является одним из примеров. Кроме того, поскольку он расположен между основными вулканическими и плутоническими породами, распределение известняка на исследуемой территории весьма своеобразно. Большинство исследований, связанных с известняком в районе исследований, проводились только в региональном масштабе, поэтому для сбора самых современных геологических данных требуется более глубокий анализ. По этой причине это исследование было направлено на изучение фаций и диагенеза известняков в южной части провинции Горонтало в Индонезии. Для достижения целей исследования будут использованы полевые исследования, в том числе мегаскопическое изучение известняка и петрографический анализ в лаборатории. Результаты показали, что известняковые фации южной части провинции Горонтало представляют собой плавучий коралловый камень. На основании петрографического анализа в коралловом флотстоуне происходят шесть различных процессов диагенеза. Шесть процессов диагенеза включают микробную микритизацию, начальную цементацию кальцита, цементацию, растворение, неоморфизм (инверсию) и неоморфизм (перекристаллизацию). Диагенетическая обстановка известняков района исследований включает три диагенетические обстановки: она начинается с процесса диагенеза в морской фреатической зоне, затем переходит в метеоритно-фреатический пояс и заканчивается процессом диагенеза в метеоритном аэрационном поясе.

Ключевые слова: диагенез, фация, горонтало, известняк.

Introduction. Diagenesis refers to the physical and chemical changes after sediment, or sedimentary rock is deposited. It does not contain metamorphism (Scholle & Ulmer-Scholle, 2003), a process involving high temperatures and pressures. Diagenesis can preserve information on the primary appearance, post-deposition history, pore water composition, and temperature. The key controllers of diagenesis are the composition and mineralogy of the sediments, the chemical composition of the pore fluids and the

rate of fluid flow, the geological history of the deposits concerning burial, uplift and sea level change, the influx of pore fluids and climatic differences (Tucker & Wright, 1990).

Changes from one diagenesis environment to another may occur multiple times in the history of carbonate diagenesis. This can be determined using texture data that has been preserved to determine the sequence of diagenesis (Longman, 1980). Changes can occur in three main diagenesis environments: marine, meteoric, and burial, all of which have predictable processes throughout geological history (Wright et al., 2003; James et al., 2005; Wright & Cherns, 2008).

Carbonate rock diagenesis comprises six major processes: dissolution, cementation, neomorphism, dolomitization, microbial micritization, and compaction. In this case, the contributing variables are pressure, temperature, mineral stability, equilibrium conditions, water influx rate, time, and structural control (Tucker & Wright, 1990). Complex characteristics influence diagenesis processes in carbonate deposits, such as micritization, dissolution, compaction, cementation, dolomitization, and recrystallization. These criteria include primary mineralogy, depositional texture, porosity and permeability, pore water chemistry, oil saturation, and sedimentary basin tectonic development (Machent et al., 2007; Morad et al., 2012; Armelenti et al., 2016; Li et al., 2017; Seibel & James, 2017).

The chemistry of the pore water, which has the primary control over the diagenesis reaction, may vary widely. In near-surface conditions, diagenesis occurs in marine, meteoric, brackish, and hypersaline brines (Morad et al., 2012; 2019; James & Jones, 2015; Swart, 2015). The complexity of these controlling parameters makes perfect modeling of the role of diagenesis on the distribution and evolutionary pathways of reservoir quality in carbonate succession fraught with difficulties.

The regional stratigraphy of Gorontalo Province's southern part refers to a geological map of Tilamuta sheets on a scale of 1: 250,000 (Bachri et al., 1997) composed of several rock formations. In regional stratigraphic order, the oldest formation is the Tinombo Formation consisting of basalt lava, andesitic lava, volcanic breccia, intercalated sandstone, green sandstone, siltstone, red limestone, gray limestone, and a small amount of thermally recovered rock. The age of this rock unit is estimated to be between the Eocene and the Early Miocene. Above it, the Middle Miocene Bilungala Volcano Formation was created, consisting of volcanic breccia, tuff, and lava. The color of this lithology ranges from gray to dark gray. The Diorite Bone Formation, which includes diorite, quartz diorite, granodiorite, and adamellite, is estimated to be Middle Miocene in age. The Tinombo and Bilungala Volcano Formations were both cut through by this unit. Aside from that, there are variations in the composition of quartz diorite, granodiorite, and adamellite, with the main components being andesine, quartz, and hornblende. The Pinogu Volcano Formation, estimated to be of Pliocene-Pleistocene age, is not aligned. This formation consists of tuff, lapilli tuff, breccia, and lava. Volcanic breccias can be found in the Bone Mountains, Mount Mongadalia, and Pusian (Apandi & Bachri, 1997). The Reef Limestone Unit, formed unconformably in the Late Pleistocene-Holocene age, is the youngest formation. It is white and solid.

This unit has been elevated into hills, while others are still developing beneath the water. The uplift of numerous limestone facies in the Limboto Basin reaches 0.0699-0.0724 mm/year, demonstrating the tectonic influence of limestone uplift (Apandi & Bachri, 1997; Permana et al., 2019; 2021). Based on the preceding, the primary goal of this research is to investigate the facies and diagenesis of limestones in the southern region of Gorontalo Province.

Research materials and methods. The research material is a limestone outcrop in Gorontalo Province's southern part. The study area is a plateau (hills) has coordinates ($0^{\circ} 29' 25''$ – $0^{\circ} 30' 05''$ N and $123^{\circ} 2' 25''$ – $123^{\circ} 03' 00''$ E) (Figure 1).

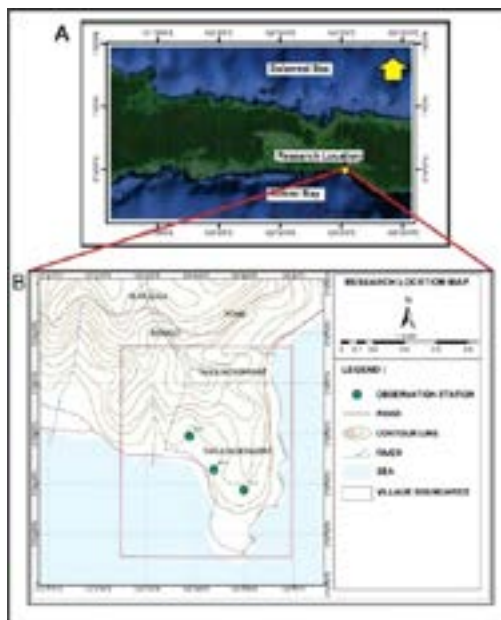


Figure 1. (A) The research location on the map of Gorontalo Province, (B) The research location is in the Tanjung Kramat area, Gorontalo City

A field survey and laboratory analysis was performed in this study. The focus of field surveys is the description and interpretation of limestone types and suitable sampling for laboratory analysis. The petrographic analysis is performed in the Geo Optics laboratory. The petrographic analysis stage begins with forming a thin section using the blocking method, which infiltrates the blue dye into the pores to distinguish the original rock pores from those formed during preparation (Dickson, 1966; Crabtree et al., 1984). Petrographic analysis was conducted with a Euromex 1053 binocular polarizing microscope equipped with a computer-connected camera (Tetley & Daczko, 2013; Serge & Senthikumar, 2017; Ofulume et al., 2018). A petrographic analysis is very useful in determining the mineral composition of the rock and the kind of porosity, which allows the type of diagenesis to be determined. The interpretation of this type of diagenesis will assist in determining the diagenesis environment of the limestone after it has been formed or deposited (Maryanto, 2012; Arosi & Wilson, 2015).

Results and Discussion. A. Facies. The results of a field survey conducted at the research site in the southern portion of Gorontalo Province demonstrate the study's morphology in the form of limestone hills (Figure 2). Petrological analysis of limestone samples reveals white rock with poorly sorted, open-packed, floating grains in the matrix and a massive structure. The limestone is known as Coralline floatstone based on petrological analysis (Embry & Klovan, 1971). It contains coral fragments, quartz minerals, micrite, and sparite.



Figure 2. Coral limestone outcrops located in the hills of the southern part of Gorontalo Province

The petrological analysis results were then compared to the petrographic analysis using a polarizing microscope (Figure 3). The petrographic analysis revealed that the carbonate rock incision was brown, the interference color was dark brown, with a particle size of 0.1 - > 4 mm, an abundance of material measuring > 2 mm, up to 11%, and the rock texture was based on the relationship between the matrix's supported grains. There is a vuggy porosity with a 12 % abundance. There are skeletal fragments in the form of coral fragments, non-skeletal grains in the form of extraclase, non-carbonate grains in the form of volcanic lithic, quartz, plagioclase, and pyroxene minerals, as well as micrite and sparite, according to its composition. The limestone facies is known as Coralline floatstone (Embry & Klovan, 1971).

A detailed description of the rock composition, namely skeletal grain in the form of coral fragments (11 percent): on the parallel nickel appearance (//) it is brown, has a porous shape, > 4 mm in size, high relief, no pleocroism is visible, and has a sort of translucent transparency. The fragments are generally replaced by sparite (calcite), and the pores are filled with micrite due to micritization. The interference color varies in order II in the appearance of crossed nickel (X).

Non-skeletal grain in the form of extraclase (3%): on the appearance of parallel nickel (//) is colorless brownish, size 0.6 mm, high relief. In the appearance of cross-linked nickel (X), the interference color varies in order of 2. Because it has been heavily crystalline, the texture cannot be determined. It is considered an extraclase because it is

more diagenetic than other grains of rock origin.

Non-carbonate grains consist of 1. Andesite lithic (2%): on the appearance of parallel nickel (//), it is colorless brownish, on the appearance of nickel crossed (X), it has an interference color of yellowish black, size 0.8 mm, porphyroafanitic texture, the composition in the form of plagioclase, quartz with a base mass of glass material. 2. Quartz (2%): on the appearance of parallel nickel (//), it is colorless, 0.1 mm in size, conchoidal shape, translucent, low relief, no pleochroism, and no fracture. On the appearance of crossed nickel (X), it has an interference color of order 1 gray, wavy dark. 3. Plagioclase (2%): on the appearance of parallel nickel (//) colorless, 0.1 mm in size, a long prismatic shape, translucent, low relief, no pleochroism, one-way fracture. On the appearance of crossed nickel (X), it has an interference color of order 1 gray, Carlsbad twinning, and the darkening angle is 14-18°. 4. Clino-Pyroxene (2%): on the appearance of parallel nickel (//), it is colorless brownish, 0.2 mm in size, a short prismatic shape, translucent, low relief, no pleochroism, and no fracture observed. The crossed nickel (X) appearance has an orange interference color of order 2, and the darkening angle is 20-22°.

The matrix consists of 1. Micrite (63%): on the appearance of parallel nickel (//), it is dark brown-yellowish brown, mineral size < 0.1 mm, moderate relief, cleavage is not observed, no pleochroism is visible, and has a type of translucent transparency. On the appearance of nickel crossed (X), it has a golden brown color. 2. Sparite (15%): on the appearance of parallel nickel (//), it is colorless, size 0.1 - 0.4 mm, moderate relief, a fracture is not observed, bladed – equant shape, blocky structure, and meniscus. The appearance of crossed nickel (X) varies by order of two. It is composed of calcite. It results from pore filling, micrite recrystallization, or changing the composition of the shell or coral.

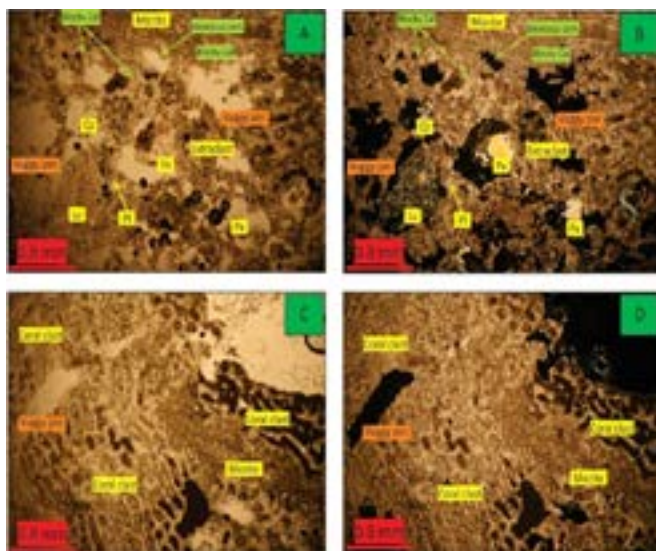


Figure 3. Petrographic analysis of rock samples showing the Coralline floatstone facies. Various types of diagenesis occur in the Coralline floatstone facies. (A) and (C) parallel nikol, (B) and (D) cross nikol

B. Diagenesis. Based on the petrographic study, six different diagenesis processes can occur in Coralline floatstone samples. Microbial micritization, initial calcite cementation, cementation, dissolution, neomorphism (inversion), and neomorphism (recrystallization) are the six processes that occur during diagenesis (Figure 3).

Microbial micritization is this process that occurs in the marine environment, and drilling activity can be carried out by organisms such as endolithic fungi, bacteria, and green algae or possibly red algae. The grain micritization process is indicated by replacing several skeleton grains with cloudy brown micrite that coats the granules. The cementation process in carbonate sediments is the main diagenetic process. It occurs when the pore-fluid is supersaturated with the cement phase, and there are no kinetic factors that hinder cement precipitation. The dissolving process requires a large volume of supersaturated water and is influenced by the selectivity of the matrix, grain shape, grain size, and skeleton properties. The neomorphism process consists of inverse, recrystallization, and coalesce neomorphism (aggrading/degrading neomorphism). Inversion is the change of one mineral to a polymorph, for example, the polymorphic transformation of aragonite to calcite and alteration of Mg calcite to calcite. While recrystallization is a change in crystal size without a change in mineralogy, for example, increasing/reducing the size of calcite crystals or the replacement (replacement) of tiny calcite crystals by larger calcite crystals (Folk, 1965).

It is possible to determine the diagenetic environment of the limestone in the study area based on petrographic analysis and diagenesis type determination using the classification (Longman, 1980), which includes three diagenesis environments: marine phreatic zone, meteoric phreatic zone, and meteoric vadose zone. The reconstruction of the history of limestone diagenesis in the southern part of Gorontalo Province is helped by the analysis of three diagenesis environments based on diagenesis type. Table 1 shows the research area's chronology or stages of limestone diagenesis.

Table 1. Stages of the diagenesis process that occurred based on relative time in limestones in the southern region of Gorontalo Province

Stages of the Diagenesis Process		Marine Phreatic Zone	Meteoric Phreatic Zone	Meteoric Vadose Zone
Relative Time				
1	Microbial Micritization			
2	Initial Calcite Cementation			
3	Cementation			
4	Dissolution			
5	Neomorphism (Inversion)			
6	Neomorphism (Recrystallization)			
7	Cement Structure Dominated by Blocky Structure			
8	Cement Structure Dominated by Meniscus Structure			
9	Vuggy Porosity			

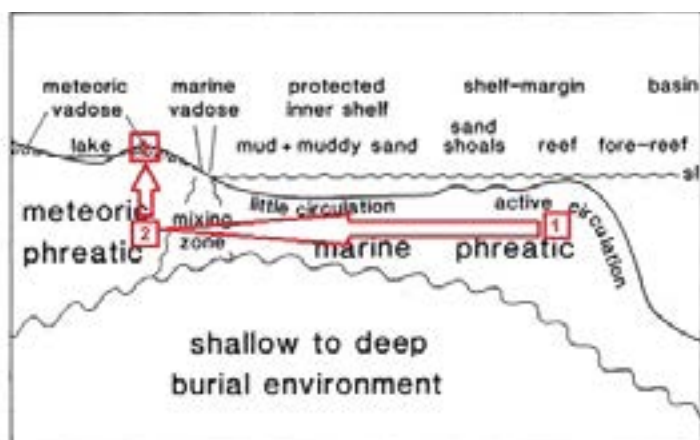


Figure 4. Environmental scheme of carbonate diagenesis in the Coralline floatstone facies in the southern area of Gorontalo Province (Tucker & Wright, 1990)

According to Table 1, the study area's chronology or stages of limestone diagenesis can be divided into three categories:

The major dissolving product in the matrix is cementation. The early steps of the diagenesis process take place in the marine phreatic zone. The process of microbial micritization and early calcite cementation characterize this stage.

The diagenesis process progresses to the second stage in the meteoric phreatic zone. The presence of a substantial dissolving process in the matrix and shell, with the matrix dominating, characterizes this stage. There is also a neomorphism process that involves inversion and recrystallization. Changes in shell composition or coral fragments into blocky calcite indicate an inversion. The process of neomorphism takes the form of recrystallization, as seen by the transformation of micrite to blocky calcite. The bladed equant form dominates the cement's morphology.

In the meteoric vadose zone, the diagenesis process reaches its third stage. The occurrence of a disintegrating process characterizes this stage. Vuggy porosity is formed as a result of this minor dissolving process. There was also a cementation process, as evidenced by the existence of a calcite cement pore filling with a meniscus structure. This is supported by the rock's cementation dominance and the presence of porosity due to extensive dissolution (Figure 4).

Conclusion. Several important conclusions can be taken from the results and discussion of facies analysis and limestone diagnosis studies in the southern portion of Gorontalo Province, including:

1. Coralline floatstone is the limestone facies found in the southern half of Gorontalo Province.

2. Based on the petrographic analysis, six different types of diagenesis processes occur in Coralline floatstone. Microbial micritization, initial calcite cementation, cementation, dissolution, neomorphism (inversion), and neomorphism (inversion) are the six diagenesis processes (recrystallization).

3. The limestone diagenetic environment in the study area consists of three diagenesis environments, which begin with the diagenesis process in the marine phreatic zone, then turn into the meteoric phreatic zone, and end in the diagenesis process in the meteoric vadose zone.

Acknowledgments. *We thank the Directorate of Technology Research and Community Service, Directorate General of Higher Education, Ministry of Education, Culture, Research and Technology, and Institute for Research and Community Service (or LPPM) of Universitas Negeri Gorontalo. Support is provided in the form of financial or legality to this research through the Decentralization Program Research in Higher Education for the Fiscal Year 2022.*

Information about authors:

Aang Panji Permana – PhD, Researcher and Senior Lecturer in Geological Engineering Study Program, Earth Science and Technology Department, Faculty of Mathematics and Natural Sciences, Universitas Negeri Gorontalo, Indonesia; aang@ung.ac.id; <https://orcid.org/0000-0002-6865-3564>;

Sunarty Suly Eraku – PhD, Researcher and Assoc. Professor in Geography Education Study Program, Earth Science and Technology Department, Faculty of Mathematics and Natural Sciences, Universitas Negeri Gorontalo, Indonesia; <https://orcid.org/0000-0002-6819-0184>;

Ronal Hutagalung – Researcher and Lecturer in Geological Engineering Study Program, Earth Science and Technology Department, Faculty of Mathematics and Natural Sciences, Universitas Negeri Gorontalo, Indonesia; <https://orcid.org/0000-0001-8142-8903>;

Dewi Rahmawaty Isa – Researcher and Lecturer in Faculty of Mathematics and Natural Sciences, Universitas Negeri Gorontalo, Indonesia; <https://orcid.org/0000-0002-6604-8379>.

REFERENCES

- Apandi T., Bachri S. (1997) Geological map sheet Kotamobagu, North Sulawesi, scale 1: 250,000. Geological Research and Development Center, Bandung.
- Armementi G., Goldberg K., Kuchle J. & De Ros L. (2016) Deposition, diagenesis and reservoir potential of non-carbonate sedimentary rocks from the rift section of Campos Basin, Brazil. *Petroleum Geoscience*, 22: 223–239.
- Arosi H.A., Wilson M.E. (2015) Diagenesis and fracturing of a large-scale, syntectonic carbonate platform. *Sedimentary Geology*, 326: 109-134.
- Bachri S., Partoyo E., Bawono S.S., Sukarna D., Surono. & Supandjono J.B. (1997) Regional geology of Gorontalo, North Sulawesi. Collection of Research and Mapping Results Papers Centre for Geological Research and Development. P. 18-30.
- Crabtree S.J., Ehrlig R. & Prince C. (1984) Evaluation of strategies for segmentation of blue-dyed pores in thin sections of reservoir rocks. *Computer vision, graphics and image processing*, 28: 1-18.
- Dickson J.A.D. (1966) Carbonate identification and genesis revealed by staining. *Sedimentary Petrology Journal*, 36(2): 491-505.
- Embry A.F., Klovan J.E. (1971) A late devonian reef tract on northeastern Banks Island, NWT. *Bull. Can. Petroleum Geol*, 19: 730–781.

- Folk R.L. (1965) Some aspects of recrystallization in ancient limestones. In: Pray L.C. and Murray R.C., Eds., *dolomitization and limestone diagenesis*, 13: 14-48. DOI: 10.2110/pec.65.07.0014.
- James N.P., Bone Y. & Kyser T.K. (2005) Where has all the aragonite gone? mineralogy of holocene neritic cool-water carbonates, Southern Australia // *Journal of Sedimentary Research*, 75: 454-463.
- James N.P., Jones B. (2015) *Origin of carbonate rocks*. John Wiley & Sons.
- Li Z., Goldstein R.H. & Franseen E.K. (2017) Meteoric calcite cementation: diagenetic response to relative fall in sea-level and effect on porosity and permeability, Las Negras Area, Southeastern Spain. *Sedimentary Geology*, 348: 1–18.
- Longman M.W. (1980) Carbonate diagenetic texture from nearsurface diagenetic environment. *Am. Assoc. Petrol. Geol. Bull.*, 64: 561-487.
- Machent P.G., Taylor K.G., Macquaker J.H. & Marshall J.D. (2007) Patterns of early postdepositional and burial cementation in distal shallow-marine sandstones: Upper Cretaceous Kenilworth Member, Book Cliffs, Utah, USA. *Sedimentary Geology*, 198: 125–145.
- Maryanto S. (2012) Limestone diagenetic records based on petrographic data of Sentolo Formation at Hargorejo Traverse, Kokap, Kulonprogo. *Indonesian Journal of Geology*, 7(2): 87-99.
- Morad S., Al-Aasm I.S., Nader F.H., Ceriani A., Gasparini M. & Mansurbeg H. (2012) Impact of diagenesis on the spatial and temporal distribution of reservoir quality in the jurassic Arab D and C members, Offshore Abu Dhabi Oilfield, United Arab Emirates. *GeoArabia*, 17: 17–56.
- Morad S., Al Suwaidi M., Mansurbeg H., Morad D., Ceriani A., Paganoni M. & Al-Aasm I. (2019) Diagenesis of a limestone reservoir (lower cretaceous), Abu Dhabi, United Arab Emirates: comparison between the anticline crest and flanks. *Sedimentary Geology*, 380: 127-142.
- Ofulume A.B., Ib K.K., Ibeneme S.I., Dioha E.C., Chinemelu E.S., Eluwa J.C. & Onyeise U.O. (2018) The petrography, geochemistry and potential applications of Ndi-Uduma Ukwu/Ohafia-Ifigh limestone, Ohafia, S.E. Nigeria. *Journal of Geosciences and Geomatics*, 6(1): 21-26. DOI: 10.12691/jgg-6-1-3.
- Permana A.P., Pramumijoyo S. & Akmaluddin. (2019) Uplift rate of Gorontalo limestone (Indonesia) based on biostratigraphy analysis. *News of the National academy of sciences of the Republic of Kazakhstan. Series of Geology and Technical Sciences*, 6(438): 6-11. DOI: 10.32014/2019.2518-170X.150.
- Permana A.P., Pramumijoyo S. & Eraku S.S. (2021) Microfacies and depositional environment of tertiary limestone, Gorontalo Province, Indonesia. *News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciences*, 2 (446): 15- 21. DOI : 10.32014/2021.2518-170X.29.
- Scholle P.A., Ulmer-Scholle D.S. (2003) A color guide to the petrography of carbonate rocks: grains, textures, porosity, diagenesis. *AAPG Memoir*, 77: 1-477.
- Seibel M.J., James N.P. (2017) Diagenesis of miocene, incised valley-filling limestones; Provence, Southern France. *Sedimentary Geology*, 347: 21-35.
- Serge N., Senthilkumar G.R. (2017) Petrography of crystalline limestone and the associated rocks occurred near Uthappanaickanoor Village, Usilampatti Block, Madurai District, Tamil Nadu, India. *IOSR Journal of Applied Geology and Geophysics (IOSR-JAGG)*, 5: 54-62.
- Swart P.K. (2015) The geochemistry of carbonate diagenesis: the past, present and future. *Sedimentology*, 62: 1233–1304.
- Tetley M., Daczko N.R. (2013) Virtual petrographic microscope: a multi-platform education and research software tool to analyse rock thin-sections. *Australian Journal of Earth Sciences*, 61(4): 631-637. DOI: 10.1080/08120099.2014.886624.
- Tucker M.E., Wright V.P. (1990) *Carbonate sedimentology*. Blackwell, Oxford, 482 p.
- Wright P., Cherns L. & Hodges P. (2003) Missing molluscs; field testing taphonomic loss in the mesozoic through early large-scale aragonite dissolution. *Geology (Boulder)*, 31(3): 211–214.
- Wright V.P., Cherns L. (2008). The subtle thief: selective dissolution of aragonite during shallow burial and the implications for carbonate sedimentology. In: Lukasik J., Simo J.A.T. (Eds.), *Controls on carbonate platform and reef development*. SEPM Special Publication no 89.

CONTENTS

M.K. Absametov, Z.A. Onglassynov, L.V. Shagarova, M.M. Muratova GIS-ASSESSMENT OF GROUNDWATER SUPPLY TO POPULATION AND BRANCHES OF ECONOMY OF KAZAKHSTAN WITH ACCOUNT TO LONG-TERM WATER DEMAND.....	6
Ye.Ye. Akylbekov, V.M. Shevko, D.K. Aitkulov, G.E. Karataeva RECYCLING OF CHRYSOTILE-ASBESTOS PRODUCTION WASTE WITH EXTRACTING MAGNESIUM AND OBTAINING A FERROALLOY AND CALCIUM SILICATES.....	19
S.S. Demessinova, D.M. Kalmanova, O.A. Dagmirzayev, I.D. Kaldybayev, N.S. Lutsenko, A.Yu. Nurgaliyev ALGORITHM FOR CONTROL OF REMOTE SENSING SPACECRAFT FOR MONITORING SUBSOIL USE OBJECTS.....	34
B. Durmagambetov, D. Abdrazakov, D. Urmanova ADVANCED METHODS OF FRACTURE GEOMETRY ANALYSIS AND PARAMETERS SENSITIVITY STUDY.....	45
A.M. Khairullaev, N.O. Berdinova, S.A. Syedina, G.B. Abdikarimova, A.A. Altayeva 3D BLOCK MODELING OF GEOMECHANICAL PROPERTIES OF ORE DEPOSITS USING MODERN GMS.....	58
N.Zh. Karsakova, K.T. Sherov, B.N. Absadykov, M.R. Sikhimbayev, T.K. Balgabekov THE CONTROL PROBLEMS OF THE LARGE DIAMETER HOLES IN PROCESSING OF THE LARGE PARTS.....	70
T. Imanaliyev, S. Koybakov, O. Karlykhanov, B. Amanbayeva, M. Bakiyev PROSPECTS FOR THE DEVELOPMENT OF WATER RESOURCES MANAGEMENT IN THE SOUTH OF KAZAKHSTAN.....	80
M. Li, T. Ibrayev, N. Balgabayev, M. Alimzhanov, A. Zhakashov WATER DISTRIBUTION IN CHANNELS OF THE MOUNTAINOUS AND PIEDMONT AREA.....	96
S.R. Massakbayeva, G.S. Aitkaliyeva, B.R. Abdrakhmanova, M.A. Yelubay, S. Azat EVALUATION OF THE PROPERTIES OF THERMODIFUSION ZINC COATING OF COUPLINGS OF PUMP-COMPRESSOR PIPES PRODUCED BY "KSP STEEL"	106

T. Mendebaev, N. Smashov PREREQUISITES FOR THE CONSTRUCTION OF A CLOSED SYSTEM OF OPENING AND DEVELOPMENT OF GROUNDWATER DEPOSITS.....	118
Zh.M. Mukhtarov, S.R. Ibatullin, M.Yu. Kalinin, G.E. Omarova DEVELOPMENT OF METHODOLOGICAL FOUNDATIONS AND RESEARCH OF TECHNICAL SOLUTIONS TO INCREASE THE VOLUME OF THE NORTHERN ARAL SEA WITH MINERALIZATION OF THE FLOW OF THE SYRDARIA RIVER.....	131
A.K. Mussina, A.S. Abdullayeva, M. Barandun THE IMPORTANCE OF CONDUCTING RESEARCH METHODS TO ASSESS THE STATE OF GLACIAL-MORAINÉ LAKES.....	147
B.B. Orazbayev, M.D. Kabibullin, K.T. Bissembayeva, G.S. Sabyrbayeva, A.J. Mailybayeva HEURISTIC APPROACH TO SOLVING THE PROBLEM OF FUZZY CONTROL OF THE REFORMING TECHNOLOGICAL PROCESS.....	156
K.N. Orazbayeva, M.K. Urazgaliyeva, Zh.Zh. Moldasheva, N.K. Shazhdekeyeva, D.O. Kozhakhmetova PROBLEMS OF INCREASING THE DEPTH OF OIL PROCESSING IN KAZAKHSTAN AND APPROACHES TO THEIR SOLUTION.....	169
A.P. Permana, S.S. Eraku, R. Hutagalung, D.R. Isa LIMESTONE FACIES AND DIAGENESIS ANALYSIS IN THE SOUTHERN OF GORONTALO PROVINCE, INDONESIA.....	185
R.G. Sarmurzina, G.I. Boiko, N.P. Lyubchenko, U.S. Karabalin, G.Zh. Yeligbayeva, N.S. Demeubayeva HYDROGEN OBTAINING FROM THE SYSTEM ACTIVATED ALUMINUM – WATER.....	196
S. Tsvirkun, M. Udovenko, T. Kostenko, V. Melnyk, A. Berezovskyi ENHANCING THE SAFETY OF EVACUATION OF VISITORS OF SHOPPING AND ENTERTAINMENT CENTRES.....	214
B.T. Uakhitova, L.I. Ramatullaeva, I.S. Irgalieva, R. Zhakiyanova, ZH.U. Zhubandykova MODELING OF INJURY PROGNOSIS IN FERROALLOY PRODUCTION.....	224

G.K. Umirova, D. Ahatkyzy

SOME FEATURES OF STRUCTURAL INTERPRETATION OF CDP 3D SEISMIC DATA UNDER CONDITIONS OF THE BEZMYANNOYE FIELD.....233

O.G. Khayitov, A.A. Umirzokov, Sh.Sh. Turdiev, V.R. Kadirov, J.R. Iskandarov

ON SOME RESULTS OF STUDYING THE CAUSES OF ANOMALOUSLY HIGH FORMATION PRESSURE ON THE HYDROCARBONS DEPOSITS OF THE BASHKENT DEEP.....247

A.S. Zhumagulov, M.T. Manzari, S.A. Issayev

PETROLEUM PLAYS AND PROSPECTIVITY OF THE SHU-SARYSU BASIN.....261

Publication Ethics and Publication Malpractice in the journals of the National Academy of Sciences of the Republic of Kazakhstan

For information on Ethics in publishing and Ethical guidelines for journal publication see <http://www.elsevier.com/publishingethics> and <http://www.elsevier.com/journal-authors/ethics>.

Submission of an article to the National Academy of Sciences of the Republic of Kazakhstan implies that the described work has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis or as an electronic preprint, see <http://www.elsevier.com/postingpolicy>), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright-holder. In particular, translations into English of papers already published in another language are not accepted.

No other forms of scientific misconduct are allowed, such as plagiarism, falsification, fraudulent data, incorrect interpretation of other works, incorrect citations, etc. The National Academy of Sciences of the Republic of Kazakhstan follows the Code of Conduct of the Committee on Publication Ethics (COPE), and follows the COPE Flowcharts for Resolving Cases of Suspected Misconduct (http://publicationethics.org/files/u2/New_Code.pdf). To verify originality, your article may be checked by the Cross Check originality detection service <http://www.elsevier.com/editors/plagdetect>.

The authors are obliged to participate in peer review process and be ready to provide corrections, clarifications, retractions and apologies when needed. All authors of a paper should have significantly contributed to the research.

The reviewers should provide objective judgments and should point out relevant published works which are not yet cited. Reviewed articles should be treated confidentially. The reviewers will be chosen in such a way that there is no conflict of interests with respect to the research, the authors and/or the research funders.

The editors have complete responsibility and authority to reject or accept a paper, and they will only accept a paper when reasonably certain. They will preserve anonymity of reviewers and promote publication of corrections, clarifications, retractions and apologies when needed. The acceptance of a paper automatically implies the copyright transfer to the National Academy of Sciences of the Republic of Kazakhstan.

The Editorial Board of the National Academy of Sciences of the Republic of Kazakhstan will monitor and safeguard publishing ethics.

Правила оформления статьи для публикации в журнале смотреть на сайтах:

www.nauka-nanrk.kz

<http://www.geolog-technical.kz/index.php/en/>

ISSN 2518-170X (Online),

ISSN 2224-5278 (Print)

Директор отдела издания научных журналов НАН РК *А. Ботанқызы*
Заместитель директор отдела издания научных журналов НАН РК *Р. Жәліқызы*
Редакторы: *М.С. Ахметова, Д.С. Аленов*
Верстка на компьютере *Г.Д. Жадыранова*

Подписано в печать 06.12.2022.

Формат 70х90^{1/16}. Бумага офсетная. Печать – ризограф.
20,0 п.л. Тираж 300. Заказ 6.