положенного к западу от озера Восток, являлся протерозойский подвижный пояс с возрастом 1.3–0.8 млрд лет (рисунок). Кроме того, вероятно, эродировались метаморфические комплексы кратонов Рукер и Моусон (рисунок). Исследования детритовых цирконов подтверждают и уточняют выделяемые по геофизическим данным провинции центральной Антарктиды.

Исследование выполнено при поддержке проекта РФФИ 15-05-05413 и проекта РНФ 16-17-10139.

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Scatterplot Matrices of the Geomorphic Structure of the Mariana Trench at Four Tectonic Plates (Pacific, Philippine, Mariana and Caroline): a Geostatistical Analysis by R programming

Mariana Trench is one of the 37 known deep-water trenches of the World Ocean, 28 of which located in the margin areas of the tectonic plates of the Pacific Ocean [1]. It forms the peripheral framing, of which five are located in the Atlantic [2] and four, in Indian Ocean [3]. Crossing four tectonic plates – Mariana, Caroline, Pacific and Philippine, – Mariana Trench creates a complex of the deeply interrelated factors and processes. Factors affecting formation, geomorphic development and bathymetric patterns of the Mariana Trench are diverse. The most important ones include geologi-

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cal, hydro-chemical, biological, geothermal, climatic, tectonic, bathymetric and geomorphological determinants. For instance, the impact of lithosphere is illustrated by a constant exchange of matter and energy between the submarine volcanoes located nearby [4]. The hydrosphere influence on the Mariana Trench is reflected by deep ocean currents bringing sediments to the trench bottom and contributing towards accumulation of the sedimental thickness layer [5].

The seafloor of the Mariana Trench is a background, on which all the processes occurring in the Mariana Trench are reflected [6]. The main morphostructure elements of the seafloor are the outskirts of the continents and of the ocean bedrock. The structure of the Mariana Trench and the nature of its relief are greatly complicated by the multiple secondary tectonic disturbances, i.e. by the occurrence of faults and displacements on grabens, horsts and lateral geologic shifts [7]. Among other trenches, Mariana Trench is distinct for its edge type associated with the marginal tectonic plate subduction processes [8]. Namely, Mariana Trench is formed in the process of the subduction of one plate beneath another.

The main part of the seabed of the Mariana Trench is composed by the oceanic crust forming rift zones of the mid-ocean ridges with a capacity of 5 to 10 km [9]. Since the system of the Mariana trench is complicated and constituent of the interrelated factors forming its tectonic structure, there are various attempt to answer the question of trench tectonics. Thus, it is discovered [10] that deformations of the trench respond to the coupling between the upper and lower plates, that is, coupling itself relating to the continental slab age-buoyancy. Nevertheless, is has been found [11] that back-arc deformation roughly correlate with upper continental tectonic plate velocity. The trench migration rates are chiefly controlled by the lower continental tectonic plate velocity [12], which in turn depends on the tectonic slab age buoyancy [13].

Choosing the right statistical methods for specific tasks of the ocean floor modelling is a crucial step in planning research. Available data may vary depending on the current research scope, be it structure of the sedimentary cover of the ocean trench, geometric features of the deep horizons (angle steepness), waves velocity characteristics as reflected by rock density, submarine earthquakes, deep ocean currents etc. Methodological approach require careful reflection of the data set and the goal of the statistical analysis. Oceanographic measurements for marine geology supported by the R programming prove an effective processing of the raw set of data on the topography of the ocean floor and variable environmental layers of the underlying rocks. Such data available online as free GIS layers in vector and raster formats have been used for the current research. Generally speaking, the ocean research methodology is based on application of various GIS with specific tools for geospatial rater of vector data processing. Both commercial ArcGIS and open-source GRASS GIS or QGIS are suited for specialized study of the seabed relief, processing attribute data of the biological and geological resources of the hadal trenches, geophysical fields and tectonic plates. The diversity of the scientific tasks and the need to study completely different properties of the trench structure recorded as objects in the machine system, led to the creation of the specialized geological and geophysical methods, GIS and different equipment and tools.

Scatterplot matrices, also known as determinant for linear correlation between the multiple variables, are an efficient way to highlight the environmental variables that might have similar correlations to the geomorphic structure of the ocean trench. The scatterplot matrix is used to solve the problem of selection of the crucial impact factors affecting the hadal formation. The application is supported by purely practical algorithms of data partition that is, inspection of the possible determinants. The data with multiple variables congregating a geo-system are particular suitable to be used for the scatterplot matrix. The matrices correlation for four tectonic plates were executed by called using {Ggally}, {data.table} and {ggplot2} libraries. In the current research the following R programming script has been used to assess correlation between factors affecting Mariana Trench geomorphology:

```
# step-1:  read in data, create data frame, delete non-available values:
MDF4 <- read.csv("Morph-9-factors.csv", header=TRUE, sep = ",")
MDF4 <- na.omit(MDF4)
row.has.na <- apply(MDF4, 1, function(x){any(is.na(x))})
sum(row.has.na)
# step-2. Indicate factor value:
MDF4$slope_class <- factor(MDF4$class)
# step-3. Create matrices of the scatter plots for four tectonic plates
sl<- ggpairs(MDF4 ,
 title= "Mariana Trench \nScatterplot Correlation Matrix by Slope Angle
Class",
 upper = list(continuous = wrap("density", alpha = 0.5, lwd = 0.3)),
 lower = list(continuous = wrap("points", color = "red", alpha = 0.5),
         combo = wrap("box", color = "orange", alpha = 0.6, lwd = 0.3)),
   diag = list(continuous = wrap("densityDiag",  color = "blue", alpha =
0.5, lwd = 0.3)))
# step-4. Add values for axis tscks (here: use small font)
pair<- sl + theme(axis.text.x = element_text(face = 3, color = "gray24",
size = 6, angle = 15),
axis.text.y = element_text(face = 3, color = "gray24", size = 6, angle = 15))
```

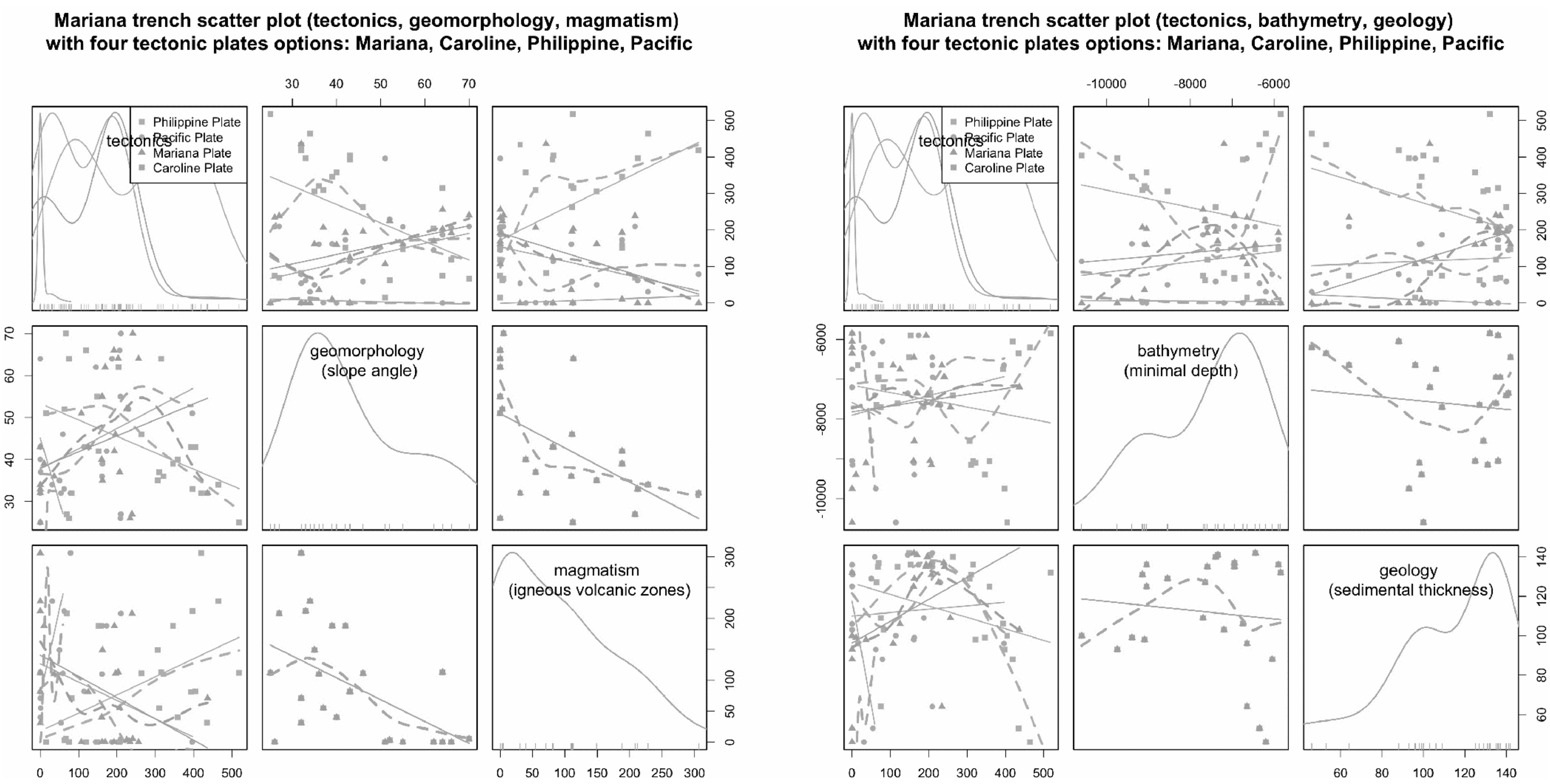

Fig. 1. Scatter plot matrices of impact factors on four tectonic plates underlying Mariana Trench

step-5. Visualize matrices of the scatter plots for four tectonic plates

Pair # plot the created matrix

The study revealed (Figure) distinct unevenness of various factors affecting Mariana Trench geomorphic structure. The bathymetric determinant of the four distinct groups of the cross section profiles cause certain variability in the sedimental thickness of the basement, slope angle steepness degree, angle aspect, depth at the basement, as well as depth values (means, median and absolute minimum). Among other factors, a magmatism of the nearby area is to be mention. The closeness of the igneous volcanic areas contribute towards earthquake frequency across four tectonic plates – Mariana, Pacific, Philippine Sea and Caroline. The results demonstrated that cross-section profiles of the Mariana Trench can be divided into clusters according to their properties, such as bathymetric (depth values), geographic (latitude and longitude), geological (width of the sedimental thickness layer), magmatism (large igneous polygon areas) and tectonic (location of the tectonic plates nearby). In the scope of current research, a functionality of R programming language has been tested. It proved to be as an effective tool for studying distribution of the environmental factors affecting the tectonic structure, as well as geomorphic properties at the seafloor basement of the Mariana Trench.

Acknowledgements. The funding of this research has been kindly provided by the CSC SOA, P.R.C. China, Beijing.

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Кристаллические протрузии как типовая структурно-тектоническая модель интрагранитных ловушек УВ и месторождение Белый тигр (Вьетнам)

Главные усилия по поискам месторождений УВ направлены на изучение осадочных отложений и структурных ловушек, приуроченных к чехольным комплексам. Правомерность такого подхода сомнению не подлежит, однако он ограничивает поиски ловушек УВ в пределах кристаллического фундамента, в частности, в пределах гранитных массивов. УВ в породах фундамента чаще всего зачисляли в неэкономический потенциал, их разведочное бурение было предоставлено воле случая (А. Сиркар), а имеющиеся приемы и методики поисков, разведки и разработки залежей УВ отработаны для осадочного чехла и зачастую неприменимы для фундамента (О.А. Шнип).

В данной работе рассмотрена постмагматическая тектоника гранитов и ее связь с формированием интрагранитных залежей углеводородов. Библиографический обзор по проблеме содержится в [4], а применительно к месторождению Белый Тигр – в [3]. Анализ данных по размещению УВ в породах фундамента позволяют сделать следующие

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