

The Republic of Peru
Mining Metallurgical Geology Research Institute (INGEMMET)

**Project for Capacity Strengthening
for
Geothermal Resource Assessment**

PROJECT COMPLETION REPORT

February 2024

**JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)**

WEST JAPAN ENGINEERING CONSULTANTS, INC.

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24-031

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Abbreviations and Acronyms

Abbreviations	English
APCI	Peruvian International Cooperation Agency
C/P	Counter Part
COVID-19	Coronavirus disease 2019
CVT	Tutupaca Volcanic Complex
DGAR	Directorate of Environmental Geology and Geological Risk
DL	Laboratories Directorate
DRG	Directorate of Regional Geology
DRME	Mineral and Energy Resources Directorate
FY	Fiscal Year
GDP	Gross Domestic Product
HQ	Headquarters
INGEMMET	Geological, Mining and Metallurgical Institute
JCC	Joint Coordinating Committee
JICA	Japan International Cooperation Agency
MEM	Ministry of Energy and Mining
MT	Magnetotellurics
MW	Megawatt
nD	n-dimensional
OJT	On the Job Training
PDM	Project Design Matrix
QC	Quality Control
R/D	Record of Discussion
West JEC	West Japan Engineering Consultants, Inc.

CHAPTER 1 Overall Project Description

1.1 Country

The Republic of Peru

1.2 Title of the Project

Project for Capacity Strengthening for Geothermal Resource Assessment

1.3 Duration of the Project

Planned : April 2020 to September 2022

Actual : April 2020 to December 2023

1.4 Background

After the pandemic of COVID-19, Peru's macroeconomic fundamentals remain strong. The pace of GDP growth is expected to increase to 2.8% over the next few years assuming a gradual improvement in business confidence and renewed investment in large scale mining projects (World Bank 2023). Along with economic growth, electricity demand is expected to increase, and by 2030, power generation capacity will need to triple from the current 14,730 MW (as of 2016).

Peru's total power generation in 2021 was 58.14 GWh, which consists of 54.9% hydro power, 39.6% thermal power, and 5.5% of other renewable energy sources. In 2008, the Department of Energy and Mines (MEM) enacted a "Statute to Promote Investment in Power Generation Using Renewable Energy" to set out a policy to convert 5% of total power generation to other renewable energy sources (small-scale hydropower, geothermal, solar, wind, geothermal and biomass). In 2010, the Presidential Decree "National Power Policy 2010-2040" set a policy goal to diversify the power supply structure with an emphasis on renewable energy and energy efficiency. The new Sustainable Energy Matrix created by MEM in 2012 was expected to develop 1,500 MW of geothermal by 2040, however, to date there is no geothermal power generation in Peru.

To foster private investment, the government of Peru has undertaken surface exploration of selected geothermal resources through INGEMMET (Instituto Geofísico Minero y Metalúrgico: Mining Metallurgical Geology Research Institute). However, due to INGEMMET's limited geothermal development expertise, the work has been challenging.

On December 30th, 2019, JICA, APCI and INGEMMET agreed to a collaboration agreement: "Project for Capacity Strengthening for Geothermal Resource Assessment". The overall objective of this project was to improve INGEMMET's capacity to execute geothermal resource studies through the transfer of technology with experts from JICA and West JEC.

To achieve the project objective, the following main activities were planned;

1. Improve capacity in geological studies for geothermal development.
2. Improve capacity in geochemical studies for geothermal development.
3. Improve capacity in processing and analyzing geophysical data (Gravity, Magnetic and Resistivity) for geothermal development.
4. Improve capacity in the evaluation of geothermal resources.

This project completion report presents the results of the work activities and project objectives, including a pre-feasibility study of the Tutupaca geothermal field which INGEMMET and West Japan Engineering Consultant Inc., West JEC (hereinafter referred to as “JICA Team”) worked together to complete. It includes a chapter for each of the main activities listed in the bullet points above. Furthermore, the report is a deliverable in the agreement signed April 2020.

The Tutupaca Volcanic Complex (CVT) is located in the Western Cordillera of the Andes of southern Peru, at the southern end of the Peruvian volcanic arc. The CVT is located approximately 60 km east of the city of Moquegua and 105 km north of the city of Tacna (Figure 1-1). The CVT covers an approximate area of 170 km². The CVT comprises three adjacent volcanic edifices; the oldest Basal Tutupaca; West Tutupaca (5,815 masl), and the Recent Tutupaca edifice located at the eastern end of the CVT, called Recent Tutupaca (5,790 masl).

The Tutupaca volcanic complex can be reached by 3 main paved routes from Moquegua and Tacna. At around the CVT, several dirt roads allow good access using 4 x 4 vehicles.



Figure 1-1 Location of the active and potentially active volcanoes of the volcanic arc of southern Peru (INGEMMET Report)

1.5 Overall Goal and Project Purpose

1.5.1 Overall Goal

To set grounds for discussions between INGEMMET (C/P), the Government of Peru and the private sector regarding the availability and the economic - social benefits of utilizing the geothermal resources of Peru for power generation.

1.5.2 Project Goals

Improve the C/P's ability to evaluate geothermal resources.

1.5.3 Expected Outputs

1. Improve the C/P capacity to plan and carry out geological studies for geothermal development.
2. Improve the C/P capacity to plan and carry out geochemical studies for geothermal development.
3. Improve the C/P capacity to plan and carry out processing and analysing geophysical data (Gravity and MT resistivity) for geothermal development.
4. Improve the C/P capacity in the evaluation of the potential of geothermal resources.

1.6 Implementing Agency

Mining Metallurgical Geology Research Institute (INGEMMET)

DRME: Dirección de Recursos Minerales y Energéticos
(Directorate of Mineral and Energy Resource)

DGAR: Dirección de Geología Ambiental y Riesgo Geológico
(Department of Environmental Geology and Geological Risk)

DL: Dirección de Laboratorios
(Laboratories Department)

DRG : Dirección de Geología Regional
(Directorate of Regional Geology)

1.7 Project Implementation Structure

The training was provided by a JICA Team of experts from West JEC. The JICA Team coordinated with the JICA office in Lima during the period of training provided to the Mineral and Energy Resources Directorate (DRME as its abbreviation in Spanish) of the C/P. Figure 1-2 shows the framework structure of the implementation of this project and Figure 1-3 shows the organization chart of the C/P enhancing in colour the departments also being benefited of this capacity building project.

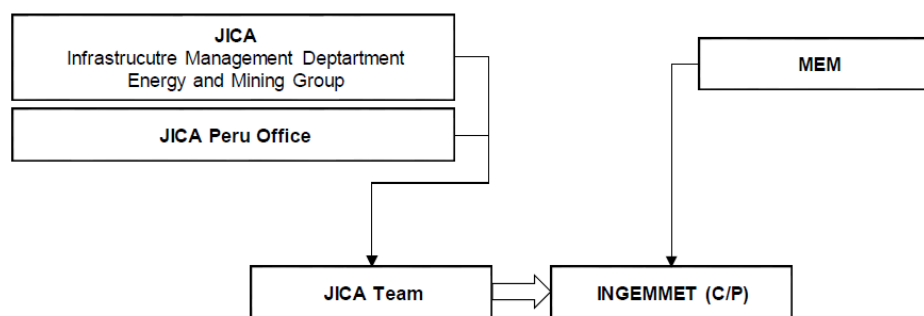


Figure 1-2 Structure of the implementation for this project.

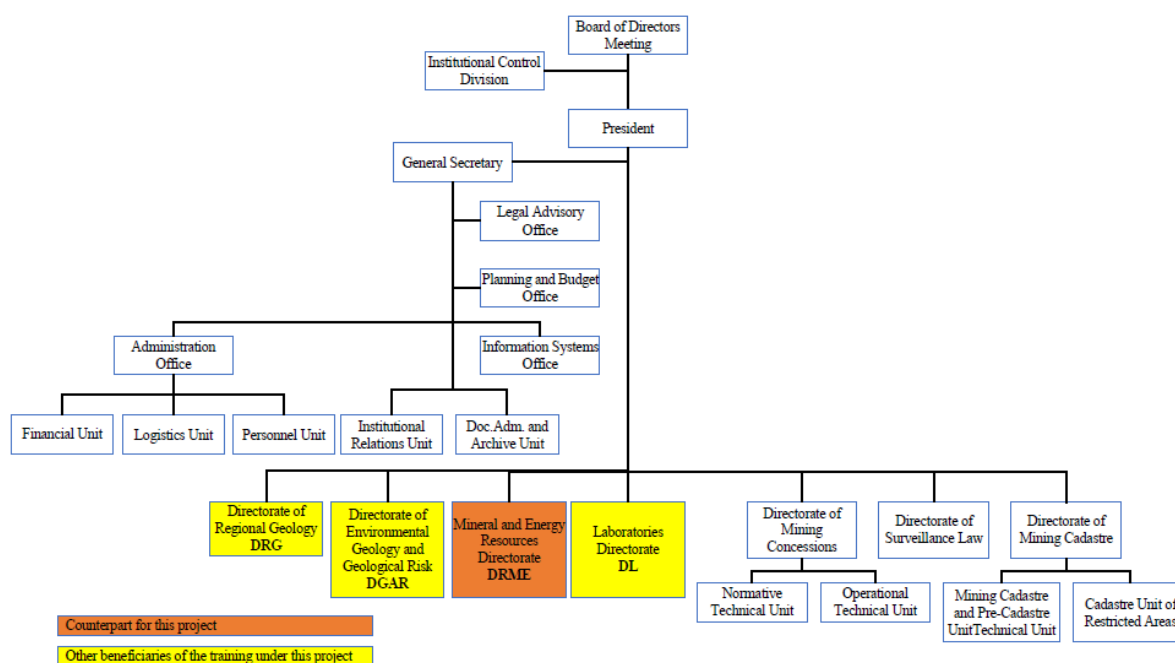


Figure 1-3 Organization chart of INGEMMET and target departments for training.

1.8 Project Implementation

1.8.1 General Aspects and COVID-19

The JICA Team obeyed instructions made from the JICA Peruvian office to prevent attacks from terrorisms, crime damages and accidents in advance. Additionally, the JICA Team followed the safety guidance made by the Peruvian office and strictly develop an emergency contact system. The worldwide pandemic of COVID-19 forced the JICA Team not to conduct OJT training in Peru. To compensate this delay of the project, the JICA Team has conducted online trainings until the pandemic travel restrictions were lifted.

1.8.2 Safety Measures

To maintain safety in the occurrence of an event of terrorism, crime and accidents, the safety procedures of JICA and the safety management standards and policies of the JICA office in Peru were observed. A communication line in case of emergency was set.

1.8.3 Project Implementation Scheme

The progress of the project was monitored by the Joint Coordination Committee (JCC) led by the C/P and MEM. The actual execution was done by the JICA Team and the C/P Team. The implementation scheme involved two aspects, with a) being related to the implementation of the program activities and b) being the personnel of the C/P that would participate in this capacity building program.

Regarding the implementation of activities, the original implementation plan called for classroom training and OJT sessions when the JICA Team was in Peru, and also called for an online session for the planning and organization of the project activities. The COVID-19 pandemic and travel restrictions required a change of plans. During 2020, it was not possible for either team to travel at all, hence, the training sessions were reorganized to be conducted online considering it was expected that in 2021 traveling for the JICA Team and for the C/P would be possible and field data could be acquired.

While the data was acquired the JICA Team provided OJT in Peru and continued transfer of knowledge through online sessions for the data processing and interpretation to support the C/P Team in the Lima and the field. Again, since it was not possible for the experts to travel, the situation forced the JICA Team and JICA to devise a way forward for the years 2021 and 2022. This was a heavy program of online training followed up by a single 15-day field trip to the Tutupaca volcano in 2022.

Regarding the members of the C/P participating in this capacity building program, there was a change in the size of the training group. The reason is because the DRME group is small (5 members) and is not fully dedicated to geothermal related activities only, therefore when the DRME conducts field works, they require the participation of members of other departments of the C/P. Hence, when field OJT was executed under this project, the participation of personnel of the other departments of the C/P was necessary. The C/P and JICA Team considered beneficial to allow members of other departments of the C/P trained in the basics of geothermal energy, therefore they were included in the online training session executed up to the end of March 2021 to allow for all personnel to share the same basic knowledge about geothermal exploration and enhance communications with other stakeholders external to the C/P (MEM, APCI, etc.).

1.8.4 Project Design Matrix, PDM

Even though the COVID-19 pandemic forced to change the original plan for this project, the modified program followed the guidelines of the Project Design Matrix (PDM) agreed between the Japanese and Peruvian authorities. The PDM interrelates the main structure of the project (Overall goal, Purpose, Outputs and Activities) with verifiable indicators, means of verification and assumptions. Refer to Annex 2).

1.8.5 Methodology of the Capacity Building

1. Method of the capacity building

The methodology followed to comply with the goals of this project, refer to Section 1-2 and to reach to its expected outputs, as shown in Figure 1-4.

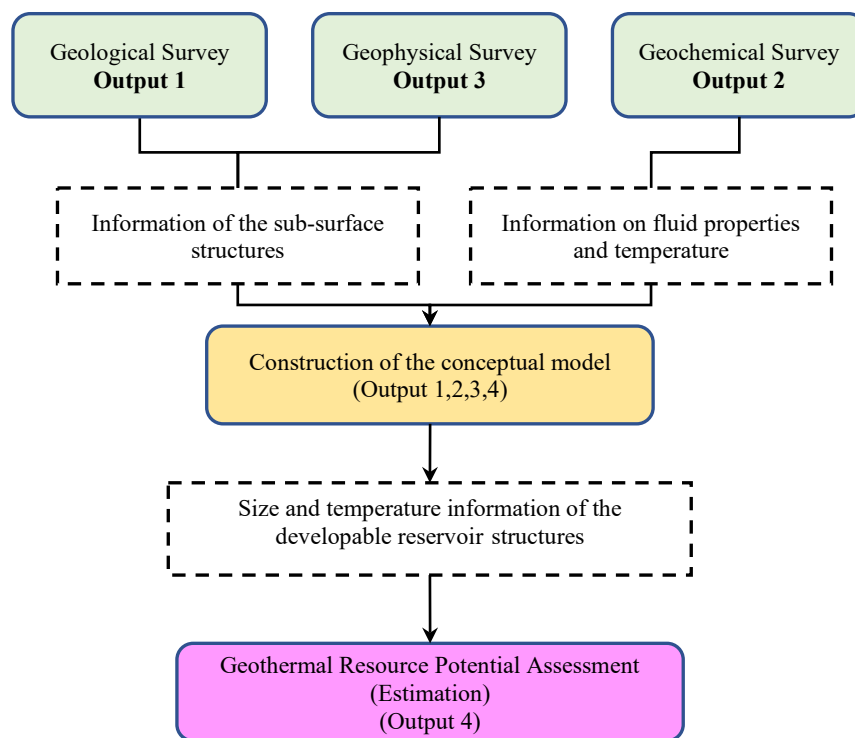


Figure 1-4 Relationship between the flow of activities and expected outputs

The project targets were described as below.

- a. To unify knowledge and criteria among the members of the C/P through online sessions.
- b. To improve capacity in the planning of field surveys through online sessions.
- c. To improve capacity in conducting on-site surveys (observation, sampling, and measurement) through field OJT. These field OJT sessions were conducted in accordance with the planned annual field surveys of the C/P and in agreement to the C/P annual budget.
- d. To provide methodologies for the pre-analysis and processing of collected data at the field for quality control (QC) through classroom OJT while the JICA Team is in Peru.
- e. To provide data processing analysis through online sessions.
- f. To provide a basis for experience considerations in the valuation of information through online sessions.
- g. To provide methodologies in the integration of all information into a geothermal conceptual model.
- h. To provide methodologies in the evaluation of the potential of the studied geothermal field.
- i. To provide methodologies in the preparation of reports to present the findings of the studies.

The project involves field OJT (oriented to train the C/P in QC of data acquisition), but the program is intended to provide capacity in processing and interpretation of data through online and in classroom OJT sessions.

2. Ensuring capacity building tailored to the C/P

Since the capacity building is aimed to transfer technology for the C/P to be self-sufficient, it was necessary to apply flexibility considering the C/P's environment that may affect its performance. The JICA Team endeavoured to understand the C/P's situation and measure the progress and results of the training accordingly making appropriate recommendations.

3. Participation of the implementation agencies

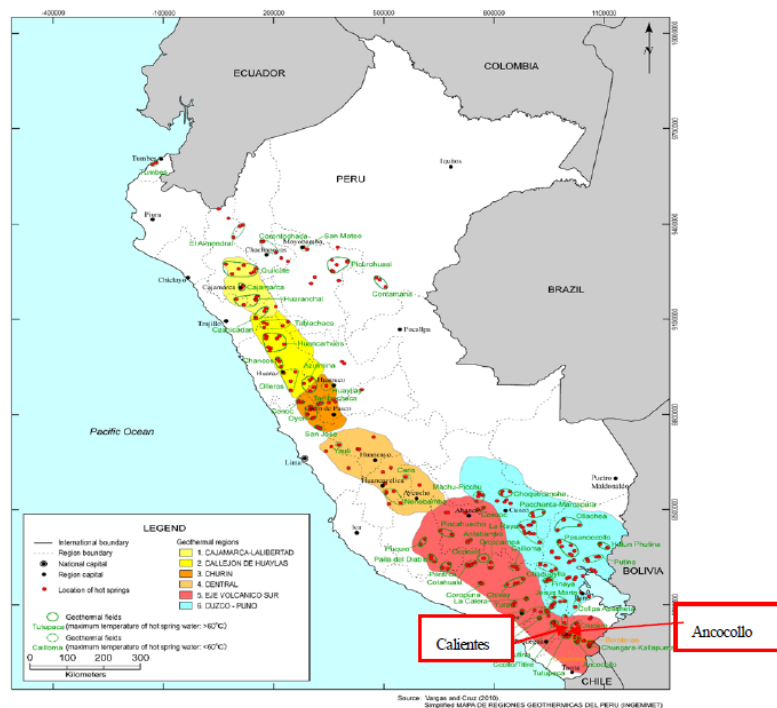
The JICA Team recommends that JICA HQ and the JICA office in Peru to encourage their counterparts in Peru, to monitor the progress of the project and to appreciate the achievement of the overall goals given in Section 1-2.

4. Field OJT sessions

Every year the C/P plans for geothermal field surveys. These field activities usually last for about 2 months depending on the annual budget of the C/P. The JICA Team accompanied the C/P during part of the period of the field surveys, to assist the C/P, through classroom OJT during the field survey, to improve their survey methods, efficiency and the QC of the acquired data. The geothermal area selected for the field studies was Tutupaca (Figure 1-5).

5. Training in Japan at the HQ of West JEC

Training sessions in Japan were planned in this project to complement the knowledge transferred online on the analysis of data and on the construction of the conceptual model. The plan was for two training sessions in Japan, each of one-week duration and available to 4 members of the C/P. However, due to the COVID-19 situation in Japan as well as in Peru in 2021 and OJT circumstances, the training in Japan was cancelled.



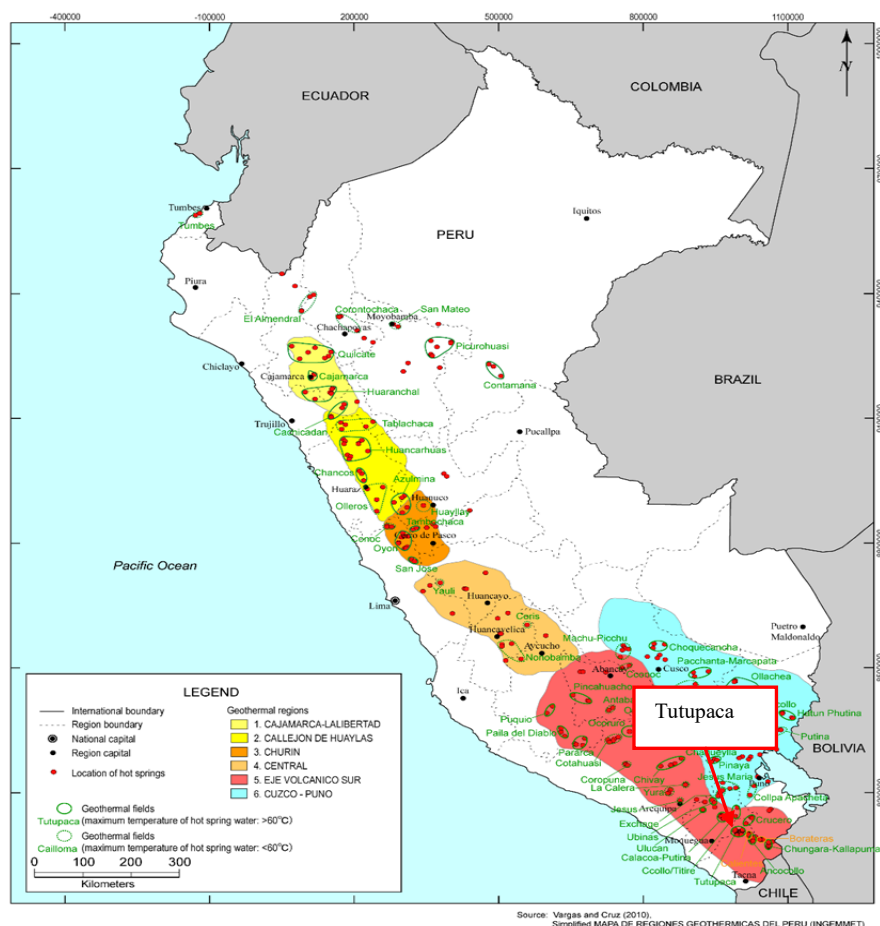


Figure 1-5 Location map of the selected site to carry out surface survey OJT.

1.9 Project Implementation Method

1.9.1 C/P Team of Trainees

Members of other departments of the C/P usually support the field survey done by the DRME for geothermal studies. Most of them are geoscientists but their expertise is oriented to the oil, gas or mining industry. The C/P requested JICA to add experts from other departments in the remote sessions and JICA accepted it. (The departments involved are those coloured in Figure 1-3. The size of the original training group of trainees increased from 5 to 15 as listed in Table 1-1.

Table 1-1 List of participants

Name	Section	Area
Vicentina Cruz	DRME	Geochemistry
Cesar Calderón Cossio	DRME	Geology
Rubén Reyes Mendoza	DRME	Geology
Freddy Arcos Alarcón	DRME	Geology
Rosemary Flores	DRME	Geophysics
Carlos Valencia	DRME	Geophysics
Darwin Calla	DRME	Geophysics
Igor Valdivia	DRME	Geophysics

Juan Casas Malpartida	DL	Geology
Anderson Palomino	DGAR	Geology
Fredy Apaza	DGAR	Geochemistry
Pablo Masias	DGAR	Geochemistry
Rafael Miranda	DGAR	Geophysics
Mayra Ortega	DGAR	Geophysics
Edu Taipe	DGAR	Geophysics

Note:

DRME: Dirección de Recursos Minerales y Energéticos
(Directorate of Mineral and Energy Resource)

DGAR: Dirección de Geología Ambiental y Riesgo Geológico
(Department of Environmental Geology and Geological Risk)

DL: Dirección de Laboratorios
(Laboratories Department)

1.9.2 Plan of implementation of the project

Annex 1 shows the flow of the activities as originally planned and shows those undertaken.

1.10 Activity throughout the Entire Contract Period

1.10.1 Progress management through online meetings

The JICA Team maintained close communication with the C/P, at least twice a month during the online training sessions and this communication was maintained throughout the period of the project. Especially, after the first field survey, these meetings were held once a week to exchange opinions on the progress of the data analysis. The results of these meetings were summarized by the JICA Team with the C/P and was shared with JICA HQ and JICA Peru office along with the materials used in the JCC.

1.10.2 JCC (Joint Coordinating Committee) and preparation of materials

To share information on the progress of the project with the stakeholders, a JCC meeting was held three times. Coordination with the relevant parties and preparation of the materials for JCC carried out respectively and in coordination by the JICA Team, the C/P, JICA HQ and the JICA Peru Office.

1.10.3 Preparation and submission of Project Monitoring Sheets

Once every 6 months, a Project Monitoring Sheet was prepared and signed jointly by the Chief Advisor of the JICA Project as well as the Project Director of INGEMMET. The Project Monitoring Sheets were submitted to JICA for comments and approvals. The Project Monitoring Sheets were submitted to the stakeholders for both the Japan and Peru sides to monitor the progress of the project. During the online training period, Project Monitoring Sheet had submitted at the timing of that the online training had a progress.

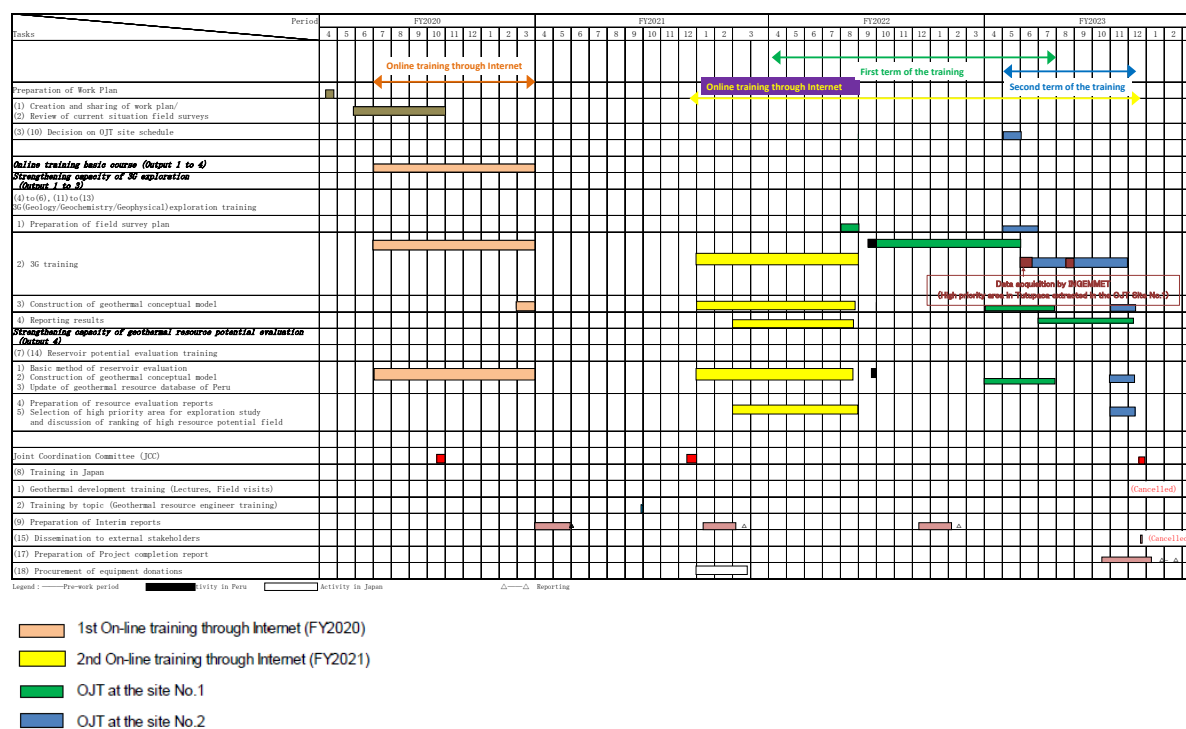
CHAPTER 2 Result of the Project

The JICA Team discussed the initial work schedule with JICA HQ to adapt to the situation of the COVID-19 pandemic in 2020 and again discussed in 2021 to accommodate the situation until 2022. Table 2-1 shows all work scheduled during the project. The first JCC was held in October 2020.

As discussed, the original plan for OJT was forced to turn into remote training sessions, and in addition the original number of trainees of the C/P grew from 5 (staff of the DRME department) to 15 (staff of other departments of the C/P). This was to take advantage of the remote sessions and taking into consideration the additional trainees belonged to departments of the C/P that, in a way or other, usually participates in the annual field surveys of the geothermal group of the DRME.

In addition to the above, given the understating of geothermal development among other departments of INGEMMET was insufficient the C/P requested, and the JICA Team accepted, to conduct the 2020 online training program to a basic level of geothermal development to standardize the understanding among all parties participating as trainees.

Table 2-1 Work Schedule



2.1 Result of the Project

2.1.1 Input by Japanese side

1. Total cost provided: 104 million Japanese Yen
2. Dispatch of Expert
 - Number of dispatched experts: 5 experts
 - Dispatched duration: 3.31 MM

The details of each expert during the field survey are shown in the below table.

NAME	TITLE	Main Activities	Duration
Enrique Lima	Chief Advisor/ Reservoir assessment	- General coordinator	12 days
Luis Urzua	Geologist B	- Training on geological survey - Training on how to develop geothermal fluid reservoir concept model	18 days
Shogo Oshima	Geochemist C	- Training on geochemical survey - Training on analyses methods of major component chemistry	12 days
Haruhiro Inagaki	Geophysicist B	- Training on MT survey - Training on MT data analysis	18 days
Yuki Lima Isomura	Geophysicist C	- Training on MT survey - Assistant of general coordination	13 days

Dispatch of expert is shown in Annex 1.

3. Counterpart training in Japan

The training in Japan was cancelled due to the COVID-19 and time limit.

	Plan	Achievement
Period	1 week	N/A
Number of trainees	4	N/A
Training subjects	Data Analysis Consideration of conceptual models	N/A
Number of training sessions	Lecture: 6 hours x 2 days Power plant tour: 1 day Lecture: 2 hours Lecture/Presentation: 6 hours	N/A

4. Donation of Measurement Equipment: Total 25 million Japanese Yen

The overview of the donated equipment and software are described in the table below.

Product name	Acquisition price	Purpose of the product
Magnetotelluric (MT) equipment	137,200.00 USD	- Measuring electric and magnetic field at the surface (MT survey) and MT data processing
Equipment for gas sampling	15,468.88 USD	- To sample gases from fumaroles
WinGlink	25,375.00 USD	- 1D and 2D MT data analyses (forward modeling and inversion)
WSINV3DMT	25,000.00 USD	- 3D MT data analysis (Inversion)

The details of the donation are listed in Annex 1.

2.1.2 Input by Peruvian side

1. Counterpart assignment: 15 persons
2. Provision: Mining Metallurgical Geology Research Institute (INGEMMET)
 - DRME: Dirección de Recursos Minerales y Energéticos (Directorate of Mineral and Energy Resource)
 - DGAR: Dirección de Geología Ambiental y Riesgo Geológico (Department of Environmental Geology and Geological Risk)
 - DL: Dirección de Laboratorios (Laboratories Department)
3. Details of the assignment
 - DRME: 8 persons
 - DGAR: 6 persons
 - DL: 1 person
4. Responsibilities of the C/P

The arrangements for the online meeting in the C/P member were conducted by the leaders in each team (Geology, Geochemistry and Geophysics). Additionally, expenses of the OJT for C/P side were borne by the C/P.

2.1.3 Activities

Descriptions in this document refer to the modification done in 2020 to the original of Work Plan to adapt the schedule and activities to the COVID-19 situation.

【Activities related to **OUTPUT 1**】

- 1-1 Based on the existing studies and in agreement to the C/P annual plan for geothermal exploration field works, select the appropriate sites where field OJT should be carried out.
- 1-2 Training on the analysis of geological information including remote sensing data.
- 1-3 Training on the zoning of mineral alteration.
- 1-4 Training on rock dating (Age determination).
- 1-5 Training on fluid inclusions.
- 1-6 Training on the construction of geothermal conceptual model integrating geological, geochemical, and geophysical surface exploration data.

1-7 Prepare the geological chapter of the integrated geothermal report of the explored areas.

【Activities related to OUTPUT 2】

2-1 Training on the analysis of the geothermal fluids to assess their origin using geochemical and isotopic ratios.

2-2 Training on the application of chemical geothermometry for geothermal fluids.

2-3 Training on the construction of a geochemical model.

2-4 Prepare the geochemical chapter of the integrated geothermal report of the explored areas.

【Activities related to OUTPUT 3】

3-1 Training on gravity exploration methods as applied to geothermal exploration.

3-2 Training on electrical and electromagnetic exploration methods as applied to geothermal exploration

3-3 Training on aerial geophysical exploration methods as applied to geothermal exploration.

3-4 Prepare the geophysical chapter of the integrated geothermal report of the explored areas.

【Activities related to OUTPUT 4】

4-1 Training on the assessment of the resource potential.

4-2 Training on the management of Peru's geothermal potential database.

4-3 Training on improved resource potential evaluation methods and exploration techniques.

4-4 Training on the identification and evaluation of geothermal systems specific to Peru.

4-5 Prepare the chapter on the resource potential assessment of the integrated geothermal report of the explored areas.

4-6 Update with the new information the geothermal resource database of Peru.

1) Working Areas

The initial plan was to hold classroom training at the INGEMMET Headquarters in Lima and Tacna cities, Peru and to have field activities in 2021 at the Ancocollo geothermal area located in the Regional Conservation Area of Vilacota Maure and at the Calientes geothermal field in 2022. However, the geothermal areas as well the scheduling had to be changed to Tutupaca due to the situation of COVID-19 pandemic and the criteria for less complicated process from environmental and financial aspects in Peru. Therefore, JICA and INGEMMET agreed to choose the Tutupaca field area as the most appropriate to carry out the OJT.

2) Counterpart Agency

Geological, Mining and Metallurgical Institute: INGEMMET, the C/P

2.1.4 Method

1) Online sessions of the First term of the training

An online session was held between the JICA team and the C/P to discuss the schedule and contents of the training. The C/P requested the JICA Team to devise a First Term training program based on the capacity of the C/P to execute, acquire and process information necessary to develop a geothermal field. The talks with the C/P revealed that, with few exceptions, most of the staffs of the C/P have been recently incorporated to the C/P workforce. Nevertheless, it was found that their understanding and capacity level to apply their individual geoscientific skills to the needs of the mining industry was acceptable. In fact, it was found that they were knowledgeable of modern techniques and able to manipulate sophisticated software and equipment commonly used in the mining and oil and gas industries.

The C/P management requested, and the JICA Team accepted, to invest the time allocated to the First Term of Training to establish a platform of common understanding with respect to what is required when applying their geoscientific expertise to a geothermal development. Although the

tools and procedures to pre-process, process, analyse and interpret geothermal field data is similar to what is done in mining and oil and gas industries the application of same geoscientific tools and the interpretation of results may differ from what they were trained for. Therefore, a need was identified to review the concepts and application of the same geoscientific tools to the geothermal industry.

As mentioned above, JICA team and the C/P collaborated to understand what the C/P requirements are for the training based on their skills. Thus, the outputs mentioned in section 2-1-3 are partially achieved.

2) Scheduling and site for the field OJT

The schedule for the 2021 field OJT had to be changed because of the COVID-19 situation. Therefore, JICA Team and JICA HQ deferred field activities to the year 2022 since finalizing their scheduling of field activities also involved the approval by JICA of equipment donation and JICA needed the donated equipment during the field work activities. It was required to define the number of field surveys that could be executed by the C/P in one year, their scheduling and the confirmation of the sites where it is most recommendable to execute these activities. To do this, consideration was paid to the need and the ease of complementing available existing data and the availability of the JICA Team to accompany the C/P at the field. All these were discussed while taking into consideration the COVID-19 situation in Japan and in Peru.

3) Executed Plan for field and classroom OJT on Geology

For the First Term of Training, the plan for geology was to include the various technical elements of geology, considering their importance and versatility: For the Second Term of Training, the modification of the plan was made with JICA.

The following areas have been covered during the remote sessions.

1. Background of the analysis and interpretation of geological structure and remote sensing data.
2. Background of the zoning of hydrothermal alteration minerals.
3. Background on rock dating.
4. Background on fluid inclusion analysis.
5. Background on the planning of a geological field survey.
6. Planning of a field survey for surface geology in consultation with C/P. The JICA Team accompanied the C/P to the field survey for about two weeks to provide field OJT in Tutupaca field.
7. Based on the above plan, training on several geological topics was carried out. This training was not only a field OJT but included online sessions.
8. Sessions for an OJT for data analysis and interpretation using actual acquired data.
9. Construction of a geological structural model with the C/P based on the results of the analysis of data obtained during the field survey.
10. Assisted the C/P to write the geological chapter including the geological model and the chapter describing the integration of all data including the integrated conceptual model of the surveyed geothermal field.

Table 2-2 The activities of geological training

Item	Data for Training	Activities
a. Geological structure delineation (including remote sensing data analysis)	INGEMMET data, published remote sensing data	C/P performs data processing and analysis under the guidance and demonstrations of experts. The results are cross-checked by experts.

b. Classification of hydrothermal alteration zones	INGEMMET data	C/P performs data processing and analysis under the guidance and demonstrations of experts. The results of analysis are cross-checked by experts.
c. Rock age determination	INGEMMET data	Based on the existing age data, C/P reviews and evaluates the history of volcanic activity.
d. Planning of geological survey	-	The plan for programmed geological survey in 2022 is prepared through the discussion between C/P and the experts.

The geothermal conceptual model is constructed primarily by the geologist based upon discussions and consultations with another geoscientists. The geologist shall consider the underground structure based on geophysical and geochemical facts leading to interpret the origin of the heat and flow of fluids in the underground. The conceptual model shall include an estimation of the heat sources and of the reservoir permeability structures that may permit the fluid to move underground.

The data and information collected during the geological surface survey of the first field survey OJT was used in the data processing and interpretation, and was integrated to the other datasets collected for geochemistry and geophysics to create the conceptual model and to assess the field potential. The results were integrated into a pre-feasibility report (in English) by the C/P's trainees under the guidance and supervision of the geology experts of the JICA Team.

During the Second Term of Training, the activities related to the capacity building on geology were carried out through online sessions in a similar manner as described in the table above but using data acquired during a second field survey carried out by the C/P alone under remote supervision from the JICA Team. Except for field surveys, all activities were carried by online sessions and emails/chat communication. The training content was flexibly modulated depending on the degree of ability acquired by the C/P trainees during the First Term of Training. The chapter on geology and of the integration into a conceptual model of the report for the second site was written by the C/P trainees in Spanish and later translated by the JICA Team into English.

Although we faced difficulties to execute the trainings and achieve the OUTPUT1 due to the pandemic situation, we could manage the training execution by devising the training methodologies and close communication with the C/P. Therefore, all activities related to OUTPUT 1 were completed during the project.

4) Executed Plan for field and classroom OJT on Geochemistry

The following areas have been covered during the remote sessions.

1. Background on fluid sampling method.
2. Background on data quality, laboratory analysis, and evaluation of chemical data.
3. Background on the analysis of the origin and evolution of geothermal fluids using geochemical trends and isotope ratios.
4. Background on geothermometry for the estimation of subsurface temperatures.
5. Background on the planning of a geochemical field survey.

Planning of a field survey for surface geochemistry was carried out in consultation with C/P Team. The JICA Team accompanied the C/P Team to the Tutupaca field area for about two weeks to provide OJT in the Tutupaca field area.

Based on the above plan, training in the following geochemistry topics was carried out. This training included online and classroom sessions for data analysis and interpretation using actual acquired data from the OJT of geochemistry sampling surveys.

1. Fluid sampling methods for waters, gases, condensates, and stable isotopes.
2. Quality evaluation of chemical analysis data and analytical methods.
3. Analysis of the origin and evolution of geothermal fluids using geochemical trends and isotope ratios.
4. Geochemical analysis and geothermometry.
5. Construction of a geochemical model with the C/P based on the results of the analysis of data obtained during the field survey.
6. Assisted the C/P to write the geochemical chapter including the geochemical model using the data collected during the field survey.

For the First Term of Training, the plan for geochemistry was to include various technical elements of geochemistry, considering their importance and versatility. For the Second Term of Training still the modification of the plan is on the making with JICA.

Table 2-3 The activities of geochemistry training

Item	Data for Training	Activities
a. Quality control of chemical data	INGEMMET data	C/P performed the data evaluation under the guidance and demonstrations of experts. The results of evaluation were cross-checked by experts.
b. Analyses and interpretations on fluid origin and evolution with chemical and isotopic data	INGEMMET data	C/P performed the data analyses and interpretations under the guidance and demonstrations of experts. The results were cross-checked by experts.
c. Liquid geothermometry	INGEMMET data	C/P performed the data analyses and interpretations under the guidance and demonstrations of experts. The results were cross-checked by experts.
d. Planning of geochemical survey	-	The plan for programmed geochemical survey in 2022 was prepared through the discussion between C/P and the experts.

The data and information collected during the geochemical survey of the first OJT field survey was used in the OJT for the data processing and interpretation. The geochemical interpretations were integrated with the geology and geophysics datasets to create the conceptual model of the field, and to assess the potential capacity of the field being studied. These results were integrated in a pre-feasibility report in English by the C/P's trainees under the guidance and supervision of the geochemistry experts of the JICA Team.

During the Second Term of Training, the activities related to the capacity building on geochemistry were carried out through online meetings using data acquired during a second site survey carried out by the C/P alone under remote supervision from the JICA Team. Except for field surveys, all activities were carried out by online session and email/chat communication. The training content

was flexibly modulated depending on the degree of ability acquired by the C/P trainees during the First Term of Training. The chapter on geochemistry and integration into a conceptual model of the work was planned to be written by the C/P trainees in English. Due to schedule time constraints, this was done in Spanish to later be translated into English and reviewed by the JICA Team.

As mentioned on the geology topics, the geochemical team could also manage to execute the trainings, thus, all activities related to OUTPUT 2 were completed during the project.

5) Executed Plan for field and classroom OJT on Geophysics

The following topics were covered during the remote sessions.

1. Background on the application of geophysical methods to geothermal exploration.
2. Background on data quality, data processing, and evaluation of geophysical data.
3. Background on the data acquisition, preprocessing, processing, analysis, and interpretation of gravity data.
4. Background on the data acquisition, preprocessing, processing, analysis, and interpretation of magnetotelluric (MT) data.
5. Interpretation of gravity and MT data for geothermal exploration.
6. Background on the planning of a geophysical field survey.
7. Planning of a field survey for gravity and MT surveys in consultation with C/P Team.
8. The JICA Team accompanied the C/P to the MT field survey for about two weeks to provide field OJT.

Additionally, training in the following geophysical topics was carried out. This training was not only field OJT but included online sessions for data analysis and interpretation using actual acquired data.

1. Gravity and MT data quality and quality of analysis and evaluation of geophysical data.
2. Gravity data acquisition, preprocessing, processing, analysis, and interpretation of gravity data for geothermal.
3. MT data acquisition, preprocessing, processing, analysis, and interpretation of magnetotelluric data for geothermal.
4. Construction of a geophysical (gravity and MT) model with the C/P based on the results of the analysis of data obtained during the site survey.
5. Assisted C/P to write the geophysical (gravity and MT) chapters including the respective models using the data collected during the field survey.

For the First Term of Training, the plan was to include various technical elements considering their importance and versatility. For the Second Term of Training, trainings of data analyses of gravity and MT that INGEMMET acquired were carried out.

Table 2-4 The activities of geophysics training

Item	Data for Training	Activities
a. Outline of geophysical surveys	-	The experts provided lectures on the procedure of surveys.
b. Quality control of geophysical data	INGEMMET data	C/P performed the data evaluation under the guidance and demonstrations of experts.
c. Analyses and interpretations of gravity survey data	INGEMMET data	C/P performed the data analyses and interpretations under the guidance and demonstrations of experts. The results were cross-checked by experts.

d. Analyses and interpretations of magneto-telluric (MT) survey data	INGEMMET data	C/P performed the data analyses and interpretations under the guidance and demonstrations of experts. The results were cross-checked by experts.
e. Compiling and interpretation of results of gravity / MT surveys	Information from the results of c) and d) above	C/P and the experts jointly conducted the compiling and interpretation.
f. Planning of geophysical surveys	-	The plan for programmed geophysical surveys in 2022 was prepared through the discussion between C/P and the experts.

The data and information collected during the geophysical surface survey of the first OJT field survey OJT was used in the data processing and interpretation and was integrated with geology and geochemistry to create a conceptual model and to assess the potential capacity of the field being studied. These results were integrated and described in the geophysics chapter part of the pre-feasibility report. This was planned to be written in English by the C/P's trainees under the guidance and supervision of the geophysics experts of the JICA Team. Due to schedule time limitation, this was written in Spanish and translated later on into English.

During the Second Term of Training, the activities related to the capacity building on geophysics were carried out through online sessions and email/chat communication in a similar manner as described in the table above but using data acquired during a second site survey carried out by the C/P alone under remote supervision from the JICA Team. Except for field surveys, all activities were carried out by online and email/chat communications. The training content was flexibly modulated following the ability acquired by the C/P trainees during the First Term of Training. The chapter on geophysics and integration into a conceptual model was planned to be written by the C/P trainees in English. Due to schedule time limitation, this was written in Spanish and later on translated by the JICA Team.

Similar to the geology and geochemistry teams, the geophysical team could also manage to execute the trainings. This included completion of the 3D MT inversion, which is essential to construct the geothermal conceptual model, by conducting numerous online trainings. As the results of these collaborations, all activities related to OUTPUT 3 were completed during the project.

6) Executed Plan for field and classroom OJT on Reservoir Evaluation

The following areas were covered during the remote sessions.

1. Background on the methods for carrying out an evaluation of the potential capacity to generate power in early stages of geothermal development.
2. Background on the Power Density and Stored Heat/Monte Carlo methods.
3. Background on the more advanced 3D simulation method.
4. Field survey with C/P Team and collection of actual data and online teaching to the potential evaluation of the fields surveyed.

This training included online sessions for the following OJT on data analysis and interpretation using the actual acquired data.

1. Integrated the analyzed results obtained from Geology, Geochemistry and Geophysics to create a reservoir conceptual model of the surveyed sites with the C/P.

2. Based on the results of the above it is expected the C/P would update the Peruvian geothermal resource database under the supervision of the JICA Team.

For the First Term of Training, the plan for potential evaluation was to include the following topics. For the Second Term of Training, the modification of the plan was made with JICA.

Table 2-5 The activities of conceptual model training

Item	Data for Training	Activities
a. Inferring subsurface structure based on geophysical surveys	INGEMMET data, results of OJT on geology and geophysics	C/P and the experts jointly conducted the study.
b. Construction of geological structural model	INGEMMET data, results of OJT on geology and geophysics	C/P and the experts jointly conducted the study.
c. Construction of subsurface fluid flow model	INGEMMET data, results of OJT on geochemistry	C/P and the experts jointly conducted the study.
d. Construction of conceptual model of geothermal system	INGEMMET data, results of OJT on geology, geochemistry and geophysics	C/P and the experts jointly conducted the study.

Table 2-6 The activities of resource assessment training

Item	Data for Training	Activities
a. Power density method	INGEMMET data, results of OJT on geology, geochemistry and geophysics	C/P and the experts jointly conducted the study.
b. Volumetric method with Monte Carlo analysis	INGEMMET data, results of OJT on geology, geochemistry and geophysics	C/P and the experts jointly conducted the study.

The data and information collected during the surface survey of the first OJT field survey was used in the data integration into a conceptual model for the geothermal resource. These results were integrated into the resource capacity potential evaluation chapter in a kind of prefeasibility report in English by the C/P's trainees under the guidance and supervision of the reservoir engineering expert of the JICA Team.

During the Second Term of Training, the activities related to the capacity building on potential were carried out online in a similar manner as described in the table above but using data acquired during a second site survey carried out by the C/P alone under remote supervision from the JICA Team. The training content was flexibly updated depending on the degree of ability acquired by the C/P trainees during the First Term of Training. The chapter on the utilization of the conceptual model to do resource capacity potential evaluation and of the work done for a second was planned to be written by the C/P trainees in English, however due to their limited ability in the language it was written in Spanish to later on be translated to English by the JICA Team.

Although the Geology, Geochemistry and Geophysical works were delayed due to the pandemic situation, the works could be finally completed. After that, activities related OUTPUT 4 were executed through the online trainings. To complete the activities, we had close communication to arrange the trainings and conduct all related works. As the result of these efforts, all activities related to OUTPUT 4 were completed during the project.

2.2 Achievement of the Project

2.2.1 Project output and Indicators

To express the achievement level towards the project target, actual achievements and progress concerning the indicators of outputs in the PDM are shown in the table below. Prior to the execution of the online trainings for the technical things, JICA team conducted the baseline survey to the C/P experts. The talks with the C/P revealed that, with few exceptions, most of the staffs of the C/P have been recently incorporated to the C/P workforce. Nevertheless, it was found that their understanding and capacity level to apply their individual geoscientific skills to the needs of the mining industry was acceptable. In fact, it was found that they were knowledgeable of modern technics and able to manipulate sophisticated software and equipment commonly used in the mining and oil and gas industries. Although the tools and procedures to pre-process, process, analyse and interpret geothermal field data is similar to what is done in mining and oil and gas industries the application of same geoscientific tools and the interpretation of results may differ from what they were trained for.

Table 2-7 Achievement for indicators of project outputs in the PDM

Output 1: Capacity of geological exploration to assess geothermal resources is strengthened.	
Objectively Verifiable Indicators	Achievement Evaluation
1-1 INGEMMET officials can utilize remote sensing technologies for geological structure analysis.	Achievement: Fair Capacity strengthening in geological exploration to assess geothermal resources is conducted. INGEMMET became able to utilize remote sensing technologies for geological structure analysis in geothermal study. In the Geoscientific Reports from INGEMMET(Geology), the detailed geological structure maps and interpretations which INGEMMET created with JICA team are described.
1-2 INGEMMET officials can develop a conceptual geothermal model of geothermal reservoirs by considering geological, geochemical and geophysical data by themselves.	Achievement: Fair Capacity strengthening in constructing a geothermal conceptual model is conducted. The discussion between geologists, geophysicists, and geochemists has been done with valuable input from INGEMMET personnel and JICA experts. INGEMMET became able to develop a conceptual geothermal model of geothermal reservoirs in Tutupaca through discussion and collaborated work with JICA team. In the Geoscientific Reports from INGEMMET(Geology), the updated conceptual model from JICA master plan (2010) are described.
1-3 INGEMMET officials can specify drilling targets in consideration of the conceptual model.	Achievement: Fair Discussion on the conceptual model is conducted. The online lecture related to the drilling target has been conducted. INGEMMET acquired knowledges how to decide drilling targets as a practical manner. However, the INGEMMET team still needs to do the actual drilling target selection by themselves. In the Geoscientific

	Reports from INGEMMET(Geology), the tentative drilling targets are shown. But the drilling target must be updated based on the updated conceptual model.
Output 2: Capacity of geochemical exploration to assess geothermal resources is strengthened.	
Objectively Verifiable Indicators	Achievement Evaluation
2-1 INGEMMET officials can analyze major chemical components and stable isotope for interpretation of the origin of geothermal fluid by themselves.	Achievement: Fair Capacity strengthening in geochemical exploration to assess geothermal resources is conducted. Geochemical study in Tutupaca by INGEMMET has been done with proper interpretations and they were summarized in a report. INGEMMET became able to analyze major chemical components and stable isotope for interpretation of the origin of geothermal fluid. In the Geoscientific Reports from INGEMMET(Geochemistry), the basic interpretations of the analyzed results of major chemical component are described.
2-2 INGEMMET officials can develop a conceptual geochemical model of geothermal reservoirs including the analysis of geothermometers by themselves.	Achievement: Fair Capacity strengthening in developing a conceptual geochemical model including the analysis of geochemical temperature is in the final stage. In the Geoscientific Reports from INGEMMET(Geochemistry), the preliminary conceptual geochemical model is de
Output 3: Capacity of geophysics exploration to assess geothermal resources is strengthened.	
Achievement Evaluation	Achievement Evaluation
3-1 INGEMMET officials can process and analyze the gravity data.	Achievement: Fair Capacity strengthening in gravity exploration to assess geothermal resources is conducted. INGEMMET became able to process and analyze the gravity data. In the Geoscientific Reports from INGEMMET(Geophysics), the detail explanations for the data analyses procedures C/P did and results of the data analyses of MT and gravity are described.
3-2 INGEMMET officials can process and analyze the geomagnetism data.	It is decided that processing and analyzing the geomagnetism data is out of scope based on the agreement by both parties.
3-3 INGEMMET officials can process and analyze the resistivity data.	Achievement: High Capacity strengthening in processing and analyzing the resistivity data is completed. Regarding the data analyses, 1D and 3D MT inversions were conducted by using the donated software. Additionally, INGEMMET personnel

	are able to conduct MT surveys, processing and analyzing by themselves. In the Geoscientific Reports from INGEMMET(Geophysics), the sophisticated MT inversion results derived from the trainings are described and detail subsurface resistivity structures are explained in the report.
Output 4: Capacity to assess potential of a geothermal reservoir is strengthened	
Achievement Evaluation	Achievement Evaluation
4-1 The database* of geothermal resources is developed through integration of data on geology, geochemistry and geophysics.	Achievement: Fair Data set of 3G studies and reservoir engineering to be stored in the database has been prepared such as geological maps, diagrams of geochemistry, geophysical maps, conceptual model, resource assessment etc.
4-2 INGEMMET officials can conduct preliminary numerical modeling of a geothermal reservoir and preliminary assessment of power potential by themselves.	Achievement: Fair A preliminary assessment of power potential has been conducted based on the conceptual model. The preliminary potential estimation by Montecarlo method was performed during the trainings and the example result of the potential estimation is described.

*Note: The Project plans to update the existing database of geothermal resources at INGEMMET. New database development is not planned.

2.2.2 Objectives and Indicators

To express the achievement level towards the project target, actual achievements and progress concerning the indicators of objectives in the PDM are shown in the table below.

Table 2-8 Achievement for indicators of objective in the PDM

Objectively Verifiable Indicators	Achievement Evaluation
1. Conceptual geothermal reservoir model is developed more accurately based on new methodologies and/or techniques introduced by the Project for geothermal resources assessment.	Achievement: Fair Capacity strengthening for geothermal resource assessment has been achieved through technical lectures and collaborated works between INGEMMET and JICA experts. In addition, JICA experts supervised INGEMMET personnel during the fieldwork in Tutupaca field involving geologists, geochemists, and geophysicists. A geothermal conceptual model of Tutupaca field has been constructed through discussion among 3G geoscientists. Based on the conceptual model, a preliminary assessment of power potential has been conducted.

2. Number of reports produced on geothermal resources assessment is more than 4 during the Project period.	Achievement: Fair During the project, INGEMMET prepared the report under the supervision of JICA experts. JICA experts provided input back and forth to improve the quality of reports.
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2.3 History of PDM Modification

The history of PDM modifications and contract changes is shown in the Table 2-9. There were three times extensions of the contract period as shown below. The first change was executed to conduct additional online trainings to mitigate the delay of the project caused by the pandemic situation. The second change was executed to provide the allocable time to procure the equipment as mentioned in 2.1.1.. The last change was done to conduct additional online trainings as same with the reason of the first change.

Table 2-9 History of PDM Modification

PDM Version	Item	Before change	After change
1	Project Period	2020 to 2022 (for two and half years after arriving first JICA experts)	<u>12 October 2020 to 11 April 2023</u>
	Inputs Japanese side	【Equipment】 N/A	【Equipment】 • <u>WinGLink</u> • <u>WSINV3DMT</u> • <u>MT measurement equipment</u> • <u>Gas sampling equipment</u>
2	Project Period	12 October 2020 to 11 April 2023	<u>2020 to 2023 (for two and half years after arriving first JICA experts)</u>
	Inputs The Japanese side	【Experts】 • Leader/Geothermal resource assessment • Geology • Geochemistry • Geophysics	【Experts】 <u>Chief Advisor</u> <u>/Reservoir assessment</u> <u>Geologist A</u> <u>Geologist B</u> <u>Geologist C</u> <u>Geochemist A</u> <u>Geochemist B</u> <u>Geophysicist A</u> <u>Geophysicist B</u> <u>Geophysics C/Admin</u>
		【Training】 • Training in Japan	【Training】 <u>N/A</u>

		【Equipment】 • WinGLink • WSINV3DMT • MT measurement equipment • Gas sampling equipment.	【Donation】 • WinGlink • WSINV3DMT • MT measurement equipment • Gas sampling equipment (<u>funnel, tubes, pumps, glass bottles, etc.</u>)
	Inputs The Peru side	【Donation】 N/A	【Donation】 - <u>Hardware environment for the donated software to run</u> - <u>Continuation of WinGlink License after expiration of the initial 3 years license.</u> - <u>Storing and maintenance (including parts) to maintain the donated geophysical and replacement of the consumables included in the donated chemical equipment.</u>
	Important Assumption	N/A	<u>Keep checking in restriction for travelling to and from Peru and for travelers from Japan to return to Japan due to COVID-19</u>
3	Inputs The Japanese side	【Experts】 Chief Advisor /Reservoir assessment Geologist A Geologist B Geologist C Geochemist A Geochemist B Geophysicist A Geophysicist B Geophysics C/Admin	【Experts】 Chief Advisor /Reservoir assessment Geologist A Geologist B Geologist C Geochemist A Geochemist B <u>Geochemist C</u> Geophysicist A Geophysicist B Geophysics C/Admin

	Model site	None	<u>Tutupaca</u>
4	N/A	(Only Achievement column updated)	

CHAPTER 3 Result of Joint Review

3.1 Result of Review based on DAC Evaluation Criteria

3.1.1 Relevance

In 2010, the Presidential Decree “National Power Policy 2010-2040” set a policy goal to diversify the power supply structure with an emphasis on renewable energy and energy efficiency. The new Sustainable Energy Matrix created by MEM in 2012 was expected to develop 1,500 MW of geothermal by 2040. However, currently there is no geothermal power generation in Peru. Thus, the Peruvian government has high demands to proceed with development of geothermal power generation projects. It is important to strengthen the ability of INGEMMET for developing geothermal resources in order to achieve this demand. JICA and INGEMMET agreed to select Tutupaca geothermal field as the OJT field since the area was evaluated as high potential area for geothermal resources in the JICA master plan study in Peru. Therefore, the project goals are satisfied with the relevance to the development policy and development needs.

The JICA team has a wealth of experience in developing geothermal resources both domestically in Japan and internationally. This expertise positions them well to support and enhance the capabilities of INGEMMET, the national institute responsible for managing Peru's geological and mining resources. INGEMMET has abundant experts for geology, geochemical and geophysics which are essential to develop geothermal resources. Therefore, the strengthening of the ability of INGEMMET is believed to contribute to facilitate geothermal development in Peru. The contents of this JICA project were regarded to be highly aligned with the current situation of geothermal development in Peru.

During the discussion during the 3rd JCC, relevant institutions were discussed about energy policy in Peru, it is believed that the discussion had enhanced their awareness and understanding on the geothermal development potential in the country. The JICA project has facilitated the geothermal developments by INGEMMET in Peru, which are one of the goals of Peruvian government to develop diversify the power supply structure.

The project was consistent with Peruvian energy policy and consistent with Japan's ODA assistance policy to the country. Thus, the relevance is high.

3.1.2 Coherence

JICA teams have elaborated to enhance the capabilities of INGEMMET during the project period. As the results of the project, all related activities to achieve the four outputs defined in the R/D were completed. These activities shall enhance the capabilities of INGEMMET and the achievement will promote the geothermal resource development in Peru. This contribution is considered to meet the consistency with development assistance policies of the Japanese government and JICA. Additionally, the contribution to promote geothermal resource developments will produce additional opportunities for projects that may utilize JICA loans.

As mentioned in Relevance, the project was consistent with Peruvian energy policy and consistent with Japan's ODA assistance policy to the country. Thus, the relevance is high.

3.1.3 Effectiveness

This project is highly contributed to enhance the ability for geothermal development through the online trainings and OJT in the Tutupaca field. The JICA Team conducted numerous online trainings during the pandemic to INGEMMET. In FY 2022, the OJT in Tutupaca field is believed to be effective in acquiring reliable and accurate data from the field. As an achievement, INGEMMET could improve their ability to carry out the exploration by themselves. Although the pandemic forced us to face difficulties to achieve the project goals, JICA Team and INGEMMET managed to handle the situations as much as possible. As the result of the efforts, all related activities related to the outputs were completed.

Project purpose, strengthening of capabilities of C/P was realized large. Thus, effectiveness is high.

3.1.4 Efficiency

The JICA Team faced difficulties to achieve our goals due to the COVID-19 pandemic situation. Additionally, the pandemic situation made it difficult to conduct field data acquisitions in the Tutupaca field, which are vital to construct the geothermal conceptual model and resource estimation in the field. JICA considered these difficulties and JICA extended the project period from September 30th, 2022 to February 29th, 2024. This extension provided the JICA team additional time to conduct online trainings and carry out additional field work to complete all activities. JICA also increased the contract amount about 13,000,000 JPY to conduct additional online trainings during the COVID-19 pandemic situation which prevented us to conduct the OJT training in Peru. The increment of the contract amount was quite effective for JICA teams to work for the training and the delay of the project schedule could be mitigated. Additionally, JICA decided to donate equipment and software for the geothermal exploration and data analyses since JICA understood that there were shortages of the equipment and software to conduct the exploration work efficiently and in accordance with industry standards. For the donations, JICA increased the contract amount about 30,000,000 JPY to procure the donations as shown in section 2-1-1. During the OJT training, the equipment worked very well for geochemical and geophysical surveys. After the data acquisitions, the donated software were utilized in the geophysical data analyses and sophisticated results were produced.

The extension of the project period and increment of the contract amount were executed quickly and appropriately by JICA, thus the JICA teams could deal with the problems due to the pandemic situation.

Due to travel restrictions caused by the pandemic situation, the methodology of capacity strengthen is changed from the on-site training to the online training through internet. However, it was difficult for the C/P to acquire skills as we expected due to limitations of available time for online training. To overcome this issue, JICA decided to extend the project period to conduct additional online trainings. As a result, we could achieve technology transfers which are able to do through online training. However, even in that case, it was believed that the online training is not sufficient to acquire and improve capabilities in geothermal resource surveys since these are basically developed based on data acquisition in the field. Thus, issues remained as of FY2021. Under these circumstances, JICA extended the project period until travel restrictions were mitigated. As a result of the extension, JICA team and INGEMMET were able to carry out field activities in Peru after the pandemic situation in FY2022. Through the field activity, INGEMMET was able to strengthen its field data acquisition capabilities. As a result of this effort, we have achieved geothermal conceptual model construction and resource assessment, which were our initial goal. Hence, the outputs of the project are valuable.

The actual project cost and period exceeded the original plan, but JICA amended the original contract quickly and appropriately to solve these issues. Thus, efficiency is high.

3.1.5 Impact

The JICA project is believed to give a positive impact on promotion of geothermal power development in Peru. In addition, during the discussion in the 3rd JCC, relevant institutions were discussed about energy policy in Peru, it is believed that the discussion had a positive impact on the geothermal development in Peru. However, the impact is not yet visible enough to achieve the project objectives and the development target by the Peruvian Government. Sustained implementation of energy policies and mechanisms should lead to larger future impact. After the project, the capabilities of INGEMMET will continue to be enhanced by making use of their experiences learned from the project. Also, they can utilize the donated equipment and software to continue exploring and assessing the potential of the many geothermal resources in Peru. This will activate the geothermal resource development in Peru and provide the resource pre-feasibility information needed to develop geothermal power plants. These enhanced capabilities will provide positive impacts to support private investment and loan projects for geothermal resource development and the opportunity to initiate for discussions between INGEMMET (C/P), the Government of Peru and the private sector regarding the availability and the economic - social benefits of utilizing the geothermal resources of Peru for power generation.

Project purpose, strengthening of capabilities of C/P was realized large. Thus, effectiveness is high.

3.1.6 Sustainability

Based on the Presidential Decree “National Power Policy 2010-2040” set a policy goal to diversify the power supply structure with an emphasis on renewable energy and energy efficiency. The new Sustainable Energy Matrix created by MEM in 2012 was expected to develop 1,500 MW of geothermal by 2040. The government of Peru has undertaken surface exploration of selected geothermal resources through INGEMMET. INGEMMET have been trained during the project and JICA Team evaluated that they could develop basic abilities for the geothermal development. Additionally, JICA donated equipment for MT data measurement and software for MT data analyses, as well as gas sampling equipment. These donated equipment and software are to be retained by INGEMMET and may be used for future work activities. As the achievement of this project, INGEMMET can utilize the knowledge gained to conduct similar exploration surveys in other geothermal field areas. Therefore, the sustainability of the learned technical capabilities were well developed during the project. Regarding the implementation system in INGEMMET, there were numerous experts who joined the trainings. Each expert has good geoscience/engineering background for explorations of mining and this background knowledge can be utilized and adapted to support the geothermal resource development. During the trainings, the JICA team enhanced their capabilities for the development of geothermal resources. Hence, JICA team evaluated that INGEMMET is able to play role for promotion of geothermal resource development in Peru as a governmental institute.

It is clarified that INGEMMET leadership to achieve renewable energy particularly in geothermal can lead to sustainable geothermal development in Peru.

Reorganization of the C/P's teams have been done and it took time to re-start the online training during the project. Therefore, there is a possibility to reorganize the teams in the future. Thus, sustainability is fair.

3.2 Key Factor Affecting Implementation and Outcomes

The purpose of this project is to build and strengthen the capacity of INGEMMET to assess geothermal resources. The activities in this project included training for geology, geochemistry and geophysics. In addition, 3G surveys as OJT would have been conducted to have classroom-based transfer of knowledge. However, this project was conducted during the COVID-19 pandemic and the travel restrictions would not allow for OJT training in Peru at the scheduled time. As an alternative way to continue with the transfer of knowledge and to compensate for the delay of the project, the JICA Team conducted online meetings until the pandemic was under control in both in Japan and Peru. JICA has amended the contract to extend the project period to conduct additional online trainings. As a result, JICA team were able to achieve technology transfers that were considered possible through online training. However, even in that case, it was believed that trainings of field data acquisitions and face-to-face group works are necessary to strengthen their capabilities in the field of geothermal resource explorations. JICA team and INGEMMET were able to carry out field activities in Peru after the pandemic situation by the extension of the project period. Thus, we evaluated the amendment of the contract to conduct the field OJT after travel restrictions was appropriate decision of JICA to achieve our goals.

During the implementation of this project, the training members from the INGEMMET were changed frequently due to their availability. Due to the COVID-19, the workload of INGEMMET accumulated. Therefore, the INGEMMET team had competing interests and limited INGEMMET team availability to attend the JICA training due to their activity in other fieldworks. However, the JICA experts continued monitoring the activity and made some recommendations by training to integrate and construct the conceptual model using actual data acquired at the field followed by potential evaluations of the Tutupaca geothermal field.

3.3 Evaluation on the results of the Project Risk Management

3.3.1 Risk management result

As described above, the project was delayed due to the COVID-19 pandemic and deciding the location for field OJT took a longer time than originally expected. JICA HQ was following the activities of the JICA Team and revising the work plans to obtain the project objectives of within the restrictive conditions of the COVID-19 pandemic by carrying out the training through remote sessions and allocated the OJT in the next FY while monitoring the pandemic situations in both Japan and Peru.

3.3.2 Result of the use of lesson learned

In the "THE MASTER PLAN FOR DEVELOPMENT OF GEOTHERMAL ENERGY IN PERU (JICA, 2012)," pointed out some issues and gave recommendations to be solved for promoting geothermal power developments in Peru. In addition, prioritization of geothermal fields in Peru for development were formulated, which gave five ranks from the high priority (highest priority is categorized as Rank A) to relatively low priority. In this project, Tutupaca geothermal field in Tacna Province, which was categorized as Rank A in JICA (2012) is selected as OJT field for technology transfer activities. A geothermal resource exploration and a geothermal resource assessment in Tutupaca were carried out as a collaborative work between the C/P and the JICA team. The selection of the objective field of OJT referring to JICA (2012) is one of use of lesson learned to accelerate geothermal resource developments in Peru. At the last JCC held in December 2023, the intension of the geothermal development in Tacna province was shown among Peruvian stakeholders. This is an important achievement derived from this project by utilizing the results of JICA (2012).

3.4 Lesson Learned

3.4.1 Restriction of executing OJT

As described above, the Project's activities and outputs have been challenging due to the pandemic COVID-19 and deciding the location for OJT took more time than expected. We had problems dealing with the delays about technical and financial aspects. To solve these problems, JICA team had close communication to share knowledge and ideas on how to handle the situation and mitigate the challenges. Additionally, we found that the online trainings were an effective way to enhance the C/P capabilities in the case that OJT could not be executed due to force majeure from the pandemic. To conduct the online trainings continuously, close communication and mutual understandings between both parties were essential.

3.4.2 OJT site selection

During the selection process, there were issues related to finding a location of a geothermal prospect that is not in a protected area, which required complicated permitting procedures due to the environmental concerns. In addition, to proceed with the drilling stage of geothermal development, support from financial institutions would likely be required. Therefore, it is necessary to have discussion between the institutions related to the geothermal development in Peru. Additionally, we need to select high potential area to facilitate the geothermal development in Peru. The regulation to development and resource potential sometimes are trade-off relationship. Thus, it is quite important to have enough discussions between JICA side and C/P to decide the site and get agreement with each other to prevent unnecessary conflict about the site selection.

3.4.3 Achievement of overall goal

In order to achieve the overall goal, formulating policies related to geothermal resource developments as an external condition is essential and it is desirable that related parties such as ministries, local governments, etc. will have an opportunity of discussion of geothermal energy development. An implementation of a small-scale geothermal power development as a pilot project might invite a discussion on the policy formulation to promote geothermal resource developments. Additionally, such pilot project will be effective to obtain recognitions and understandings of geothermal development as a renewable energy within Peruvian domestic and state governments.

CHAPTER 4 For Achievement of Overall Goals after Project Completion

4.1 Prospects to Achieve the Overall Goal

The overall goal was to facilitate multiple discussions on the economic and social benefits and development potential of geothermal energy between INGEMMET, the government and private companies.

Table 4-1 Prospect to achieve overall goal in the PDM

Objectively Verifiable Indicators	Achievement Evaluation
Accurate geothermal resource information based on the conceptual reservoir model is shared and discussed at the place where the government and private companies participate (Research report meeting for the government, seminars for private sector, INGEMMET website, academic society, etc.).	A preliminary geothermal assessment in Tutupaca field has been conducted. The necessity of the discussion with the government and private sectors related to geothermal resources are recognized among the project implementing parties (MEM, INGEMMET, APCI, JICA). In addition, accumulation of data and information of geothermal resource in Peru, which will contribute to geothermal development in Peru, is believed to be accelerated by INGEMMET, since capacity strengthening of geothermal resource study in INGEMMET is achieved. On the other hand, it is desirable to have discussion for establishment of geothermal development policy among related parties such as central and local governments. The overall goal 3 years after completion of the project is expected to be fairly achieved.

4.2 Plan of Operation and Implementation Structure of the Peruvian side to achieve the Overall Goal

During the project, the JICA Team held Joint Coordinating Committees (JCC) meetings that were attended by INGEMMET, APCI, MEM, JICA HQ and JICA Peru Office. In the last JCC held in December 2023, it was mentioned that the knowledge information, experience, and know-how gained from this project will be utilized in INGEMMET. As the result of this project, the overall goal was achieved with satisfactory improvement by INGEMMET. Therefore, the JICA Team believes that INGEMMET can lead the geothermal development in Peru.

As the result of the project, the capabilities and implementation structure of INGEMMET were developed. To achieve the overall goal, INGEMMET has to enhance their capabilities and maintain the implementation structure in future.

The Project has conducted geothermal resource study in Tutupaca field in Tacna. It is expected that the study will promote geothermal development in Tacna. To invite private sector in geothermal development in Tacna, establishment of energy policies in regional government for renewable energy development is expected, which will bring multiple discussion of geothermal energy development among all related parties, such as INGEMMET, government and private companies.

4.3 Recommendations for the Peruvian side

The restrictions imposed by the global pandemic caused a major delay in the project and imposed changes in the methodology for the delivery of the training program. However, this major global issue was properly handled by all the institutions involved through close and continuous communication, allowing the execution and completion of the program. Thus, despite a major global issue that disrupted travelling schedules and limited, face-to-face training sessions, the project was able to go ahead with the delivery of the lectures and training material remotely.

Additionally, to the issue presented by the pandemic, an issue encountered during the training program was the constant rotation of the personnel of INGEMMET during the project, though it is an internal matter. If organization allows a core team to be maintained for a number of years, that will effectively retain and share the knowledge share with the group.

The INGEMMET geophysical team is one of the best teams working in high altitudes that the JICA Team has seen operating. They have the potential to become the leader of MT data acquisition in South America.

Due to constraint of gas sample analysis, an uncertainty for the conceptual model is remained, since the fumaroles near Mt. Tutupaca were not analysed. These critical thermal features and the gas compositions are critical for understanding fluid sources and potential reservoir temperatures. Thus, it is recommended that INGEMMET continues to develop their capabilities for gas sampling and analysis

The Tutupaca field is selected as a demonstration field. The project implemented a geothermal resource study divided into two steps of regional surface study and a detailed surface study in the field. Although a geothermal conceptual model of Tutupaca was constructed in the project, uncertainty still remains for the conceptual model, such as gas temperatures, the influence of magmatic fluids in the reservoir, etc. It is recommended to conduct more detailed studies for delineating resource potential areas to examine the possibility of exploratory well drilling. Further geothermal study in Tutupaca will contribute to the discussion of geothermal development between INGEMMET, the government and private companies.

The geothermal resource study in Tutupaca field and the technical strengthening of INGEMMET is expected to be contributed to the acceleration for geothermal development in Peru. The technical strengthening of INGEMMET achieved in the project will contribute to the mitigation of the resource development risk in Peru.

The Master Plan for Development of Geothermal Energy in Peru (JICA, 2012) pointed out that the governmental organization shall conduct the resource exploration to reduce resource risk, since geothermal resources are only developed by the private sector seems to be difficult for acceleration of geothermal development. In terms of such recommendations shown by JICA (2012), achievement of capacity strengthening of INGEMMET in this project contributes to geothermal development in Peru.

4.4 Monitoring Plan from the End of the Project to Ex-post Evaluation

The monitoring of the project's achievement after the project completion is recommended to be done by maintaining contacts with INGEMMET and related institutions such as APCI, MEM, JICA Peru, etc. They will keep in track the implementation situation of the geothermal development in Peru. Monitoring and follow-up will help assess whether the project achieved the intended goals and objectives and will allow JICA to measure the impact its projects have on the targeted beneficiaries and to learn from the successes and failures encountered during implementation. During the last JCC,

there was a discussion related to the geothermal pilot project in Tacna. So, it is a chance to keep monitoring and follow up the geothermal development in Peru.

ANNEX 1

Results of the Project

Operative Plan

Version 0 Annex 3

October, 2019

Project Title: Project for Capacity Strengthening for Geothermal Resource Assessment

Inputs	Year	Monitoring															Remarks	Issue	Solution
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3			
Expert																			
Leader/Geothermal fluid reservoir assessment	Plan																		
Geology	Actual																		
Geochemistry	Plan																		
Geophysics	Actual																		
Geophysical exploration	Plan																		
Equipment	Actual																		
New one(1) MT (recommended to be prepared by INGEMMET)	Plan																		
Training in Japan	Actual																		
Training of understanding Geothermal power generation	Plan																		
In-country/Third country Training	Actual																		

Activities	Sub-Activities		Year	1st Year				2nd Year				3rd Year				4th Year				5th Year				Responsible Organization	Achievements	Issue & Countermeasures	
				I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV				
Output 1: Capacity to assess geothermal resources on geology aspect is strengthened.																											
1-1 To conduct trainings on geological structure and remote sensing.			●	●				Plan																			
								Actual																			
1-2 To conduct trainings on the zone of conversion minerals.			●	●				Plan																			
								Actual																			
1-3 To conduct trainings on age determination.			●	●				Plan																			
								Actual																			
1-4 To conduct trainings on how to develop geothermal fluid reservoir concept model, which is based on surface geochemical data and geophysical exploration data.			●	●				Plan																			
								Actual																			
1-5 To develop reports on the geothermal resources.			●	●				Plan																			
								Actual																			
Output 2: Capacity to assess geothermal resources on geochemical aspect is strengthened.																											
2-1 To select survey target site(s) on geothermal resources in accordance with annual working plan.			●	●				Plan																			
								Actual																			
2-2 To conduct trainings on how to develop concept model.			●	●				Plan																			
								Actual																			
2-3 To conduct trainings on analytical methods on major component chemistry and isotopic ratio on the origin of geothermal fluid, solute geochemistry of geothermal fluid, acidification, processes and analysis of geochemical information, geological.			●	●				Plan																			
								Actual																			
2-4 To develop reports on the geothermal resources.			●	●				Plan																			
								Actual																			
Output 3: Capacity to process and analyze geophysics data such as gravity, earth magnetism, resistivity is strengthened.																											
3-1 To conduct trainings on gravity survey and magnetic exploration.			●	●				Plan																			
								Actual																			
3-2 To conduct trainings on resistivity such as electrical exploration and electromagnetic exploration.			●	●				Plan																			
								Actual																			
3-3 To conduct trainings on ground and airborne geophysical exploration methods described above.			●	●				Plan																			
								Actual																			
3-4 To develop reports on the geothermal resources.			●	●				Plan																			
								Actual																			
Output 4: Capacity to assess geothermal fluid reservoir is strengthened.																											
4-1 To conduct trainings on how to assess geothermal fluid reservoir.			●	●				Plan																			
								Actual																			
4-2 To conduct trainings on development and management of database.			●	●				Plan																			
								Actual																			
4-3 To develop new techniques which enable to improve the ways of geothermal fluid reservoir assessment and geothermal exploration.			●	●				Plan																			
								Actual																			
4-4 To conduct trainings on how to identify and to assess unique geothermal system in Peru.			●	●				Plan																			
								Actual																			
4-5 To develop reports on the geothermal resources.			●	●				Plan																			
								Actual																			
4-6 To add information and data obtained by the project activities and to update the INGEMMET database.			●	●				Plan																			
								Actual																			

Duration / Phasing	Plan																			
	Actual																			

Monitoring Plan		Year	1st Year				2nd Year				3rd Year				4th Year				5th Year				Remarks	Issue	Solution
			I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV			
Monitoring																									
Joint Coordinating Committee		Plan																							
		Actual																							
Set-up the Detailed Plan of Operation		Plan																							
		Actual																							
Submission of Monitoring Sheet		Plan																							
		Actual																							
Monitoring Mission from Japan		Plan																							
		Actual																							
Joint Monitoring		Plan																							
		Actual																							
Post Monitoring (will be held after three years of the completion of the Project)		Plan																							
		Actual																							
Reports/Documents																									
Interim report		Plan																							
		Actual																							
Project Completion Report		Plan																							
		Actual																							
Public Relations																									
		Plan																							
		Actual																							
		Plan																							
		Actual																							

(*) The present Plan of Operation may vary due to mutual agreement of the Parties.



Project Monitoring Sheet II (Revision of Plan of Operation)

Version 1

Dated 17 May 2021

Project Title: Project for Capacity Strengthening for Geothermal Resource Assessment

Inputs										Plan	2020	2021										2022										2023										Remarks		Issue	Solution
										Actual	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV																		
Expert											10: 11: 12	1: 2: 3	4: 5: 6	7: 8: 9	10: 11: 12	1: 2: 3	4: 5: 6	7: 8: 9	10: 11: 12																										
Chief Advisor /Reservoir assessment										Plan																																			
Geologist A										Actual																																			
Geologist B										Plan																																			
Geochemist A										Actual																																			
Geochemist B										Plan																																			
Geophysicist A										Actual																																			
Geophysicist B										Plan																																			
Geophysics C/Admin										Actual																																			
Equipment										Plan																																			
New one(1) MT (recommended to be prepared by INGEMMET)										Actual																					List of donation of equipment discussed in the first JCC; Geology: 3D graphic software (Leapfrog) Geochemistry: Package of gas sampling equipment Geophysics: Equipment for MT measurement														
Training in Japan										Plan																																			
Geothermal development training (lecture, fields visits)										Actual																						Restriction of travelling to Peru due to pandemic and due to the vaccination situation in Japan and in Peru may cause further delays of programmed activities in Peru..	Monitoring COVID-19 situation and Vaccination schedule in Japan and in Peru												
Training by topic (geothermal resource engineer training)										Plan																																			
										Actual																																			
Activities										Year	2020	2021										2022										2023										Responsible Organization		Achievements	Issue & Countermeasures
Sub-Activities											IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	Japan	INGEMMET																
Output 1 : Improve capacity in geological studies for geothermal development																																													
1-1 To select site(s) for training on geothermal resource exploration and assessment based on existing data, in accordance with annual working plan.										Plan																																			
1-2 To conduct trainings on analysis and interpretation of geological structure and remote sensing data.										Actual																																			
1-3 To conduct trainings on zoning of hydrothermal alteration minerals.										Plan																																			
1-4 To conduct trainings on dating.										Actual																																			
1-5 To conduct trainings on fluid inclusion.										Plan																																			
1-6 To conduct trainings on how to develop a conceptual geothermal model, which is based on geological, geochemical and geophysical exploration data.										Actual																																			
1-7 To develop reports on geothermal resources.										Plan																																			
										Actual																																			
Output 2:Improve capacity in geochemical studies for geothermal development																																													
2-1 To conduct trainings on analysis of major chemical components and isotopic ratio for the interpretation of the origin of geothermal fluid.										Plan																																			
2-2 To conduct trainings on analysis of geochemical temperature of geothermal fluid.										Actual																																			
2-3 To conduct trainings on how to develop conceptual geochemical model.										Plan																																			
2-4 To develop reports on the geothermal resources.										Actual																																			
										Plan																																			
										Actual																																			
Output 3:Improve capacity in processing and analyzing geophysical data (Gravity, Magnetic and Resistivity) for geothermal development.																																													
3-1 To conduct trainings on gravity survey and magnetic exploration.										Plan																																			
3-2 To conduct trainings on resistivity such as electrical exploration and electromagnetic exploration.										Actual																																			
3-3 To conduct trainings on airborne geophysical exploration methods.										Plan																																			
3-4 To develop reports on the geothermal resources.										Actual																																			
										Plan																																			
										Actual																																			

Output 4:Improve capacity in the potential evaluation of geothermal resources.																																			Data integration, conceptual modeling, data base and geothermal potential are objectives yet to be achieved.				allow to in a shorter period carry out field survey in two fields (one accompanied and one supervised by the Consultant) and reach the objectives of the project.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
4-1 To conduct trainings on development and management of database.	●																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													</

Project Monitoring Sheet II (Revision of Plan of Operation)

Version 2

Dated December 2021

Project Title: Project for Capacity Strengthening for Geothermal Resource Assessment

[illegible]

[illegible]

Project Monitoring Sheet II (Revision of Plan of Operation)

Version 3

Dated 24 November 2023

[illegible]

Output 4: Improve capacity in the potential evaluation of geothermal resources.

[illegible]

Project Monitoring Sheet II (Revision of Plan of Operation)

Version 4

Dated 26 December 2023

[illegible]

Output 4: Improve capacity in the potential evaluation of geothermal resources.

[illegible]

ANNEX 1-g: List of Donated Equipment

業務名称 (Name of Project) : Project for Capacity Strengthening for Geothermal Resource Assessment
対象国 (Country) : Peru
事業担当部課 (Division in Charge) : Team2, Energy and Mining Group, Infrastructure Management Department

	物品名称 Product name	規格・品番 Standard/Product number			個数 Number of pieces	取得価格 Acquisition price			検査合格日 Inspection passing date	配置場所 Location	現況 Current conditions					
						取得価格 Price	通貨 Currency	日本円換算 取得価格 JPY								
1	電磁探査測定器（更新システム搭載） MAGNETOTELLURIC EQUIPMENT WITH UPDATED SYSTEM UN (01) SET DE EQUIPOS DE MAGNETOTELURICA CON SISTEMA ACTUALIZADO				1 SET	137,200.00	USD	¥15,944,012	2022/3/8	INGEMMET	稼働中 In operation					
UMT用(Ultra wideband MT) のフィールドデータ取得ユニット Field data acquisition unit for UMT EQUIPO DE PROSPECCION MAGNETOTELURICA		PHOENIX	MTU-5C (NEW)	10502	(3)											
UMT用(Ultra wideband MT) のフィールドデータ取得ユニット Field data acquisition unit for UMT EQUIPO DE PROSPECCION MAGNETOTELURICA			MTU-5C (NEW)	10862												
UMT用(Ultra wideband MT) のフィールドデータ取得ユニット Field data acquisition unit for UMT EQUIPO DE PROSPECCION MAGNETOTELURICA			MTU-5C (NEW)	10503												
付属品： Includes as Accessories： Incluye como Accesorios：																
ブロードバンド磁気センサーインダクションコイル Broadband Magnetic Sensor Induction Coil for UMT, MT, AMT SENSOR DE MAGNITOMETRO		PHOENIX	MTC-150 (NEW)	57264	(3)											
ブロードバンド磁気センサーインダクションコイル Broadband Magnetic Sensor Induction Coil for UMT, MT, AMT SENSOR DE MAGNITOMETRO			MTC-150 (NEW)	57265												
ブロードバンド磁気センサーインダクションコイル Broadband Magnetic Sensor Induction Coil for UMT, MT, AMT SENSOR DE MAGNITOMETRO			MTC-150 (NEW)	57296												
10ピンコイルケーブル、20 M 10 pin Coil Cable CABLE BOBINA DE 10 PINES, 20 M (9 UNID.)			SQL20-10 (NEW)	-	(9 UNITS)											
電位電極、5ケース、キャリングケース付き Porous Pot Electrode, case of 5, with carrying case ELECTRODO DE RECIPIENTE POROSO, 13 CM 7,25 CM, CAJA DE 5-30 CM, 25 CM 20CM # 6 KG) CON ESTUCHE DE TRANSPORTE (3 UNID.)			PES-5D (NEW)	-	(3 UNITS)											
追加の64GB SDカード（産業用仕様、広温度範囲対応） Additional 64 GB SD card, Industrial Grade, Wide Temperature TARJETA SD ADICIONAL DE 64 GB, GRADO INDUSTRIAL, TEMPERATURA AMPLIA (3UNID.)			64-SD (NEW)	-	(3 PCS)											
QA/QC機器の時系列記録モードを備えたUMTデータ取得ファームウェア UMT Data acquisition firmware with Instrument QA/QC, time series recording modes FIRMWARE DE ADQUISICION DE DATOS UMT CON INSTRUMENTO QA/QC MODOS DE GRABACION DE SERIES TEMPORALES (NOTA INSTALADA DENTRO DEL ARTICULO 1 (3 UNID.))			FW-1 (NEW)	-	(3 UNITS)											
MTデータベースマネージャのシングルユーザー向けの譲渡不可能なライセンスパック EMpower, Advance MT database manager: Single User, non-transferable Licence - 3 Pack PAQUETE DE 3 LICENCIAS INTRANSFERIBLES PARA UN SOLO USUARIO DEL ADMINISTRADOR DE BASE DE DATOS DE POWER ADVANCE MT (01 UNID.)			EMPOWER-VI-3 (NEW)	-	(3ライセンス 1 UNIT)											
2	噴気ガス採取器具一式 EQUIPMENT SET FOR GAS SAMPLING UN (01) SET DE EQUIPAMIENTO PARA MUESTREO DE GASES				1 SET	15,468.88	USD	¥1,797,639	2022/3/8	INGEMMET	稼働中 In operation					
付属品： Includes as Accessories： Incluye como Accesorios：																
ポリプロピレンサンプリングじょうご Polypropylene sampling funnel EMBUDO DE MUESTREO DE POLIPROPILENO		THERMOCHEN	NEW	-	(2 UNITS)											
チタンプローブ Titanium probe SONDA DE TITANIO (01UNID.)				-	(1 UNIT)											
ステンレス鋼の凝縮コイル SS condensing coil SERPENTIN DE CONDENSACION DE ACERO INOXIDABLE (01UNID.)				-	(1 UNIT)											
水/凝縮液器 Water/condensate traps TRAMPAS DE AGUA/CONDENSADO (02 UNID.)				-	(2 UNITS)											
タイゴンチューブ Tygon tubing TUBO TYGON (02 UNID.)				-	(2 UNITS)											
プラスチックホースクランプ Plastic hose clamps ABRAZADERAS DE MANGUERA DE PLASTICO (20 UNID.)				-	(20 UNITS)											
手動真空ポンプ Hand vacuum pump BOMBA DE VASIO MANUAL (02UNID.)				-	(2 UNITS)											
フォームおよびシリコンプラグ Foam and silicone plugs TAPONES DE ESPUMA Y SILICONA (05 UNID.)				-	(5 UNITS)											
ステンレス鋼サンプリングフローティー SS sampling flow tee T DE FLUJO DE MUESTREO DE ACERO INOXIDABLE (01UNID.)				-	(1 UNIT)											
ステンレス鋼ホースコネクタ SS hose barbs CONECTORES DE MANGUERA DE ACERO INOXIDABLE (04 UNID.)				-	(4 UNITS)											
テフロンチューブ Teflon tubing (various diameters) TUBO DE TEFLON (VARIOS DIAMETROS) (45 UNID.)				-	(45 UNITS)											
フィールドDLリンスボトル Field DI rinse bottles BOTELLAS DE ENJUAGUE FIELD DL (02 UNID.)				-	(2 UNITS)											
テフロンバイコネクター Teflon tubing connectors CONECTORES DE TUBERIA DE TEFLON(04 UNID.)				-	(4 UNITS)											
スポイト Syringes JERINGAS (04 UNID.)				-	(4 UNITS)											
必要なすべてのボトル準備装置一式 Includes all required bottle preparation equipment INCLUYE TODO EL EQUIPO DE PREPARACION DE BOTELLAS REQUERIDO (01 SET.)				-	(1 SET)											
ガラスサンプリングボトル Glass sample bottles and Vacuum pump FRASCOS DE MUESTREO DE VIDRIO (10 UNID.)				-	(10 UNITS)											
ヘリウム同位体サンプリングクランプ Helium isotope sampling clamps PINZAS DE MUESTREO DE SOTOPE DE HELIO (06 UNID.)				-	(6 UNITS)											
トレイ Trays BANDEJAS(05 UNID.)				-	(5 UNITS)											
銅パイプ Copper tubes TUBOS DE COBRE (15 UNID.)				-	(15 UNITS)											
SO2サンプリングガラスインピンジャー SO2 sampling glass impingers IMPACTADORES DE VIDRIO DE MUESTREO DE SO2 (04 UNID.)				-	(4 UNITS)											
メスシリンダー Graduated cylinder GRADUADOS (01 UNID.)				-	(1 UNIT)											
使い捨てフィルターカプセル Disposable filter capsules CAPSULAS DE FILTRO DE ELIMINACION (20 UNID.)				-	(20 UNITS)											
吸引ろ過用熱水冷却コイル Brine cooling coil for vacuum filtration SERPENTIN DE ENFRIAMIENTO DE SALMUERA (01UNID.)				-	(1 UNIT)											
3	WINGLINKソフトウェア（1Dおよび2D用） WINGLINK SOFTWARE FOR 1D and 2D UN(01) SOFTWARE WINGLINK PARA 1D y 2D				1	25,375.00	USD	¥2,948,829	2022/3/18	INGEMMET	稼働中 In operation					
4	WSINW-30MTソフトウェア（3D用） WSINW SOFTWARE FOR 3D UN(01) SOFTWARE WSINW PARA 3D				1	25,000.00	USD	¥2,905,250	2022/3/18	INGEMMET	稼働中 In operation					



PERÚ

Ministerio
de Energía y Minas

Instituto Geológico, Minero y
Metalúrgico - INGEMMET

ANNEX 1-h: Certificate of
Handover for Donated Equipment

Lima, 18 marzo del 2022

CARTA N° 16 -2022-INGEMMET/GG-OA

Señor:

NAKAGAWA, TAKEHARU

Representante Residente en el Perú de la Agencia de Cooperación Internacional del Japón - JICA

Presente. -

Asunto : Recepción de equipos y software donados

Referencia : Acta de Recepción de Equipos y Software donados

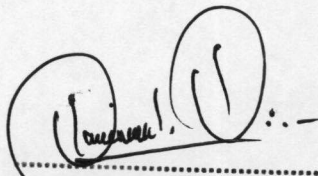
De mi consideración:

Mediante el presente me dirijo a usted en atención al documento de la referencia, mediante el cual se confirma la recepción y conformidad de los equipos y software donados por vuestra representada, aceptados por el Instituto Geológico Minero y Metalúrgico - INGEMMET mediante Resolución de Presidencia N° 011-2022-INGEMMET/PE de fecha 03 de febrero del 2022,

En tal sentido agradecemos la donación efectuada, los cuales serán usados en las actividades del Proyecto para el "Fortalecimiento de la Capacidad para la Evaluación de Recursos Geotérmicos" en el Perú.

Sin otro particular, hago propicia la oportunidad para expresarle a usted mis sinceras consideraciones.

Atentamente,


Lic. LUIS ALBERTO DÁVILA DÁVILA
DIRECTOR
Oficina de Administración
INGEMMET

CC.UL, DRME
C. Patrimonial, Archivo
JRTA/jjvg



Siempre
con el pueblo



Firmado digitalmente por DIAZ YOSA
Victor Manuel FAU 20112919377 hard
Empresa: Instituto Geológico, Minero y
Metalúrgico
Motivo: Firma del documento
Fecha: 2022/02/03 12:00:09-0500

Resolución de Presidencia

N° 0011-2022-INGEMMET/PE

Lima, 3 de febrero de 2022

VISTOS: La Carta N° JO-2021/512 del Representante Residente de la Agencia de Cooperación Internacional del Japón – JICA, el Informe Técnico N° 001-2022-INGEMMET/UL-CP del área funcional de Control Patrimonial de la Unidad de Logística, el Informe N° 0071-2022-INGEMMET/OA-UL de la Unidad de Logística, el Informe N° 0013-2022-INGEMMET/GG-OA de la Oficina de Administración y el Informe N° 0019-2022-INGEMMET/GG-OAJ de la Oficina de Asesoría Jurídica; y,

CONSIDERANDO:

Que, el Instituto Geológico, Minero y Metalúrgico (en adelante, INGEMMET) es un Organismo Público Técnico Especializado del Sector Energía y Minas, con personería jurídica de derecho público, goza de autonomía técnica, económica y administrativa, constituyendo un Pliego Presupuestal, de conformidad a lo previsto en el Reglamento de Organización y Funciones aprobado por Decreto Supremo N° 035-2007-EM;

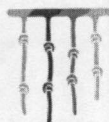
Que, el Decreto Legislativo N° 1439, Decreto Legislativo del Sistema Nacional de Abastecimiento, establece que el Sistema Nacional de Abastecimiento es el conjunto de principios, procesos, normas, procedimientos, técnicas e instrumentos para la provisión de los bienes, servicios y obras, a través de las actividades de la Cadena de Abastecimiento Público, orientadas al logro de los resultados, con el fin de lograr un eficiente y eficaz empleo de los recursos públicos;

Que, de conformidad con el artículo 6 del citado Decreto Legislativo, la Dirección General de Abastecimiento del Ministerio de Economía y Finanzas es el ente rector del Sistema Nacional de Abastecimiento y tiene entre sus funciones ejercer, la máxima autoridad técnico-normativa de dicho Sistema, aprobar la normatividad y los procedimientos que lo regulan; así como, programar, dirigir, coordinar, supervisar y evaluar la gestión de las actividades que lo componen:

Que, mediante Resolución Directoral N° 0015-2021-EF/54.01 la Dirección General de Abastecimiento del Ministerio de Economía y Finanzas, aprueba la Directiva N° 0006-2021-EF/54.01 “Directiva para la gestión de bienes muebles patrimoniales en el marco del Sistema Nacional de Abastecimiento” (en adelante, LA DIRECTIVA), la misma que tiene por objeto regular la gestión de los bienes muebles que formen parte o sean susceptibles de incorporación al patrimonio de las entidades del Sector Público que se encuentran bajo el ámbito del Sistema Nacional de Abastecimiento;

Que, el literal b) del numeral 4.2 del artículo 4 de LA DIRECTIVA, señala que los Actos de Adquisición son aquellos que permiten obtener bienes muebles a través de la donación, reposición y fabricación; asimismo, el artículo 7 de LA DIRECTIVA, establece que, a través de la donación, el donante transfiere a título gratuito bienes muebles de propiedad privada susceptibles de ser incorporados al registro patrimonial a favor del donatario;

Esta es una copia auténtica imprimible de un documento electrónico archivado del Instituto Geológico, Minero y Metalúrgico, aplicando lo dispuesto por el Art. 25 de D.S 070-2013-PCM y la Tercera Disposición Complementaria Final del D.S 026-2016-PCM. Su autenticidad e integridad pueden ser contrastadas a través de la siguiente dirección web: Url: <https://srvstd.ingemmet.gob.pe/BuscaTuDocumento> e ingresando la siguiente clave : G79D9GQB



Siempre
con el pueblo

Que, por su parte, el numeral 10.1 del artículo 10 de LA DIRECTIVA, señala que para la aceptación de donación proveniente del extranjero, se requiere que el donante presente un escrito dirigido al donatario comunicando su decisión de donar un bien mueble, el mismo que contendrá, como mínimo, la siguiente información: a) Identificación del donante y domicilio; b) Beneficiario (s) en caso que el donante así decida declararlo; c) Lugar de origen o procedencia de la donación; d) Descripción y características de los bienes muebles; e) Cantidad y valor estimado de los bienes muebles; f) Finalidad de la donación; g) Estado de los bienes muebles; y, h) Otra información que considere relevante;

Que, el numeral 10.3 del artículo 10 de LA DIRECTIVA, señala que la decisión del donatario por la cual se acepta la donación proveniente del extranjero es emitida conforme a lo establecido en el numeral 9.4 del artículo 9 de LA DIRECTIVA, que establece que la decisión del donatario por la cual se acepta la donación es emitida, mediante resolución, por el Titular de la Entidad u Organización de la Entidad, o el funcionario que se delegue, la cual debe contener, como mínimo, la descripción del bien mueble, su valor y disponer la incorporación del bien mueble al patrimonio, así como la suscripción del Acta de Entrega – Recepción, conforme al Anexo N° 02;

Que, de conformidad con lo dispuesto por el artículo 2 del Texto Único Ordenado de la Ley del Impuesto General a las Ventas e Impuesto Selectivo al Consumo, no están gravados con el impuesto, entre otros, la importación o transferencia de bienes que se efectúe a título gratuito, a favor de Entidades y Dependencias del Sector Público;

Que, mediante Carta N° JO-2021/512 del 5 de enero de 2022, el Representante Residente de la Agencia de Cooperación Internacional del Japón - JICA, comunica que la referida agencia, ha decidido donar al INGEMMET los equipos y softwares señalados en el anexo que adjunta, detallando las especificaciones técnicas de cada uno de ellos, precisando que dichos equipos serán destinados para la evaluación de los recursos geotérmicos en el sur del Perú y utilizados en la etapa de campo del "Proyecto para el fortalecimiento de la capacidad para la evaluación de recursos geotérmicos";

Que, mediante Informe Técnico N° 001-2022-INGEMMET/UL-CP del 21 de enero de 2022, el área funcional de Control Patrimonial de la Unidad de Logística, señala que la donación efectuada constituye un aporte para el desarrollo de la actividad minera y geológica del país, pues permitirá obtener mayor información de la estructura interna, tamaño y profundidad de los sistemas geotermales, y recomienda aceptar la donación de los bienes cuyas características técnicas patrimoniales están registradas en el anexo que adjunta;

Que, mediante Informe N° 0019-2022-INGEMMET/GG-OAJ del 2 de febrero de 2022, la Oficina de Asesoría Jurídica opina que resulta legalmente viable aceptar la donación de los bienes efectuada por la Agencia de Cooperación Internacional del Japón - JICA;

Que, por las consideraciones expuestas, resulta necesario emitir el acto resolutivo que acepte la donación de los bienes efectuada por la Agencia de Cooperación Internacional del Japón - JICA, cuyas características se encuentran detalladas en el Anexo que forma parte integrante de la presente resolución, así como disponer que se realicen las acciones correspondientes para la incorporación en los registros patrimoniales del INGEMMET de los bienes materia de donación y la suscripción del Acta de Entrega - Recepción respectiva;

Con el visado de la Gerencia General, de las Oficinas de Administración y Asesoría Jurídica, así como de la Unidad de Logística; y,

De conformidad con lo dispuesto en la Directiva N° 0006-2021-EF/54.01 "Directiva para la Gestión de Bienes Patrimoniales en el Marco del Sistema Nacional de Abastecimiento" aprobada por Resolución Directoral N° 0015-2021-EF/54.01, y con las atribuciones y responsabilidades contenidas en el Reglamento de Organización y Funciones del INGEMMET, aprobado mediante Decreto Supremo N° 035-2007-EM;

SE RESUELVE:

Artículo 1. ACEPTAR la donación de bienes efectuada por la Agencia de Cooperación Internacional del Japón - JICA a favor del Instituto Geológico, Minero y Metalúrgico - INGEMMET por un valor de US\$ 202,920.26 (Doscientos dos mil novecientos veinte y 26/100 dólares americanos) cuyas características técnicas están detalladas en el Anexo que forma parte integrante de la presente Resolución.

Artículo 2. AGRADECER a la la Agencia de Cooperación Internacional del Japón – JICA por la donación de los bienes detallados en el Anexo que forma parte integrante de la presente Resolución.

Artículo 3. La donación efectuada por la Agencia de Cooperación Internacional del Japón – JICA a favor del Instituto Geológico Minero y Metalúrgico – INGEMMET por un valor ascendente a US\$ 202,920.26 (Doscientos dos mil novecientos veinte y 26/100 dólares americanos), no se encuentra gravada con el Impuesto General a las Ventas y el Impuesto Selectivo al Consumo, de conformidad con lo dispuesto por el artículo 2 del Texto Único Ordenado de la Ley del Impuesto General a las Ventas e Impuesto Selectivo al Consumo.

Artículo 4. DISPONER que el área funcional de Control Patrimonial y la Unidad Financiera lleven a cabo las acciones correspondientes para la incorporación en los registros patrimoniales del Instituto Geológico, Minero y Metalúrgico - INGEMMET de los bienes materia de donación.

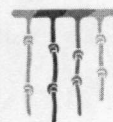
Artículo 5. AUTORIZAR al área funcional de Control Patrimonial a efectuar las acciones correspondientes que aseguren el cumplimiento de lo dispuesto en la presente Resolución, mediante la suscripción del Acta de Entrega - Recepción respectiva.

Artículo 6. DISPONER la publicación de la presente Resolución en el Portal Institucional del Instituto Geológico, Minero y Metalúrgico-INGEMMET: www.gob.pe/ingemmet.

Regístrese y comuníquese.

Documento firmado digitalmente

ING. VÍCTOR M. DÍAZ YOSA
Presidente Ejecutivo
INGEMMET



APENDICE DEL RESOLUCION DE PRESIDENCIA EJECUTIVA Nº - 2022-INGEMMET/PE
RELACION DE EQUIPOS Y SOFTWARES DONADOS POR LA AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON - JICA EN EL MARCO DEL PROYECTO "FORTALECIMIENTO DE LA CAPACIDAD PARA LA EVALUACION DE RECURSOS GEOTERMICOS EN EL PERU"

RECURSOS GEOTERMIICOS EN EL PERU								
ITEM	DENOMINACIÓN	DETALLE TECNICO			ESTADO DE CONSERVACIÓN	IMPORTE EN US\$ AMERICANOS		
		MARCA	MODELO	SERIE				
1	UN (01) SET DE EQUIPOS DE MAGNETOTELURICA CON SISTEMA ACTUALIZADO					137,200.00		
	EQUIPO DE PROSPECCION MAGNETOTELURICA	PHOENIX	MTU-5C (NEW)	10502	BUENO			
	EQUIPO DE PROSPECCION MAGNETOTELURICA	PHOENIX	MTU-5C (NEW)	10862	BUENO			
	EQUIPO DE PROSPECCION MAGNETOTELURICA	PHOENIX	MTU-5C (NEW)	10503	BUENO			
	Incluye como Accesorios :							
	SENSOR DE MAGNETOMETRO	PHOENIX	MTC-150 (NEW)	57264	BUENO			
	SENSOR DE MAGNETOMETRO	PHOENIX	MTC-150 (NEW)	57265	BUENO			
	SENSOR DE MAGNETOMETRO	PHOENIX	MTC-150 (NEW)	57296	BUENO			
	CABLE DE BOBINA DE 10 PINES, 20 M (9 UNID.)	PHOENIX	SCL20-10 (NEW)	5/5	BUENO			
	ELECTRODO DE RECIPIENTE POROSO, 13 CM 7.25 CM, CAJA DE 5-30 CM, 25 CM 20 CM @ 6 KG) CON ESTUCHE DE TRANSPORTE (3 UNID.)	PHOENIX	PE-SD (NEW)	5/5	BUENO			
	TARJETA SD ADICIONAL DE 64 GB, GRADO INDUSTRIAL, TEMPERATURA AMPLIA (3UNID.)	PHOENIX	64-SD (NEW)	5/5	BUENO			
	FIRMWARE DE ADQUISICIÓN DE DATOS UMT CON INSTRUMENTO QA/QC MODOS DE GRABACIÓN DE SERIES TEMPORALES NOTA INSTALADA DENTRO DEL ARTICULO 1 (3 UNID.)	PHOENIX	FW-1 (NEW)	5/5	BUENO			
	PAQUETE DE 3 LICENCIAS INTRANSFERIBLES PARA UN SOLO USUARIO DEL ADMINISTRADOR DE BASE DE DATOS DE POWER ADVANCE MT (01 UNID.)	PHOENIX	EMPOWER-V1-3 (NEW)	5/5	BUENO			
	2	UN (01) SET DE EQUIPAMIENTO PARA MUESTREO DE GASES						15,345.26
		Incluye como Accesorios :						
		EMBUDO DE MUESTREO DE POLIPROPILENO (02 UNID.)	THERMOCHEM	NEW	5/5		BUENO	
		SONDA DE TITANIO (01 UNID.)	THERMOCHEM	NEW	5/5		BUENO	
SERPENTÍN DE CONDENSACIÓN DE ACERO INOXIDABLE (01UNID.)		THERMOCHEM	NEW	5/5	BUENO			
TRAMPAS DE AGUA/CONDENSADO (02 UNID.)		THERMOCHEM	NEW	5/5	BUENO			
TUBO TYGON (02UNID.)		THERMOCHEM	NEW	5/5	BUENO			
ABRAZADERAS DE MANGUERA DE PLÁSTICO (20 UNID.)		THERMOCHEM	NEW	5/5	BUENO			
BOMBA DE VACÍO MANUAL (02UNID.)		THERMOCHEM	NEW	5/5	BUENO			
TAPONES DE ESPUMA Y SILICONA (05 UNID.)		THERMOCHEM	NEW	5/5	BUENO			
T DE FLUJO DE MUESTREO DE ACERO INOXIDABLE (01 UNID.)		THERMOCHEM	NEW	5/5	BUENO			
CONECTORES DE MANGUERA DE ACERO INOXIDABLE (04 UNID.)		THERMOCHEM	NEW	5/5	BUENO			
TUBO DE TEFLÓN (VARIOS DIÁMETROS) (45 UNID.)		THERMOCHEM	NEW	5/5	BUENO			
BOTELLAS DE ENJUAGUE FIELD DL (01 UNID.)		THERMOCHEM	NEW	5/5	BUENO			
CONECTORES DE TUBERÍA DE TEFLÓN (04 UNID.)		THERMOCHEM	NEW	5/5	BUENO			
JERINGAS (04 UNID.)		THERMOCHEM	NEW	5/5	BUENO			
INCLUYE TODO EL EQUIPO DE PREPARACIÓN DE BOTELLAS REQUERIDO (01 SET.)		THERMOCHEM	NEW	5/5	BUENO			
FRASCOS DE MUESTREO DE VIDRIO (10 UNID.)		THERMOCHEM	NEW	5/5	BUENO			
PINZAS DE MUESTREO DE SOTOPE DE HELIO (06 UNID.)		THERMOCHEM	NEW	5/5	BUENO			
BANDEJAS (05 UNID.)		THERMOCHEM	NEW	5/5	BUENO			
TUBOS DE COBRE (15 UNID.)		THERMOCHEM	NEW	5/5	BUENO			
IMPACTADORES DE VIDRIO DE MUESTREO DE 502 (04 UNID.)		THERMOCHEM	NEW	5/5	BUENO			
GRADUADOS (01 UNID.)		THERMOCHEM	NEW	5/5	BUENO			
CAPSULAS DE FILTRO DE ELIMINACIÓN (20 UNID.)		THERMOCHEM	NEW	5/5	BUENO			
SERPENTIN DE ENFRIAMIENTO DE SALMUERA (01 UNID.)		THERMOCHEM	NEW	5/5	BUENO			
3		UN (01) SOFTWARE WINGLINK PARA 1D Y 2D	S/M	S/M	S/S	BUENO	25,375.00	
4		UN(01) SOFTWARE WISINV PARA 3D	S/M	S/M	S/S	BUENO	25,000.00	
TOTAL GENERAL US\$ DOLARES AMERICANOS						202,920.26		

LIC. JORGE LUIS ARANA
Unidad de Logística
INGEMMET

**ACTA DE RECEPCION DE EQUIPOS DONADOS POR LA AGENCIA DE COOPERACIÓN
INTERNACIONAL DEL JAPÓN – JICA CORRESPONDIENTES A LOS ÍTEM 1 Y 2 REGISTRADOS EN EL
ANEXO DE LA RESOLUCION DE PRESIDENCIA N° 011-2022-INGEMMTE/PE DEL 03 DE FEBRERO
DEL 2022**

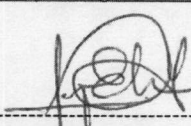
Mediante el presente los abajo firmantes dan conformidad a la recepción de los equipos registrados con el Ítem 1 y 2 del Anexo de la Resolución de Presidencia N° 011-2022-INGEMMET/PE emitido el 03 de febrero del 2022, mediante el cual la entidad acepto la donación ofertada por la Agencia de Cooperación Internacional del Japón - JICA, los mismos que se encuentran depositados en custodia del Almacén a cargo de la Unidad de Logística.

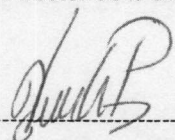
Los equipos recepcionados fueron verificados por el personal de la Dirección de Recursos Minerales y Energéticos – DRME del INGEMMET los cuales tiene, las siguientes características:

NOMBRE BIEN	MARCA	MODELO	SERIE
Ítem N° 1 : Set de (03) Equipos de Magnetotélúrica con Sistema Actualizado	Según Factura Comercial que se adjunta	Según Factura Comercial que se adjunta	Según Factura Comercial que se adjunta
Ítem N° 2 : Set de Equipamiento para Muestro de Gases	Según Factura Comercial que se adjunta	Según Factura Comercial que se adjunta	Según Factura Comercial que se adjunta

Siendo las 11:30 del día martes 08 de marzo del 2022 se firma la presente acta en señal de conformidad de lo recibido de parte de la Agencia de Cooperación Internacional del Japón – JICA.

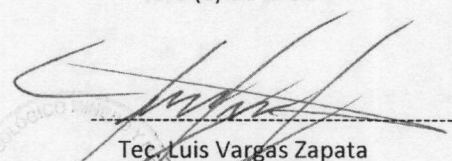
**Por la Dirección de Recursos
Minerales y Energéticos – DRME**


Ing. Jorge Chira Fernandez
Director de la DRME


Lic. Vicentina Cruz Paucara
Profesional de la DRME

Por la Unidad de Logistica - UL


Lic. Jorge Tafur Arana
Jefe (e) de la UL


Tec. Luis Vargas Zapata
Jefe de Almacén



**ACTA DE RECEPCION DE SOFTWARES DONADOS POR LA AGENCIA DE COOPERACIÓN
INTERNACIONAL DEL JAPÓN – JICA CORRESPONDIENTES A LOS ÍTEM 3 Y 4 REGISTRADOS EN EL
ANEXO DE LA RESOLUCION DE PRESIDENCIA N° 011-2022-INGEMMET/PE DEL 03 DE FEBRERO
DEL 2022**

Mediante el presente los abajo firmantes dan conformidad a la recepción por descarga virtual de los archivos necesarios para la instalación de los softwares registrados con el Ítem 3 y 4 del Anexo de la Resolución de Presidencia N° 011-2022-INGEMMET/PE emitido el 03 de febrero del 2022, mediante el cual la entidad acepto la donación ofertada por la Agencia de Cooperación Internacional del Japón - JICA, los mismos que se encuentran en custodia por la Actividad Prospección Geofísica de la Dirección de Recursos Minerales y Energéticos.

Los archivos de instalación fueron descargados por el personal de la Dirección de Recursos Minerales y Energéticos - DRME con apoyo de la Oficina de Sistemas de Información - OSI, los cuales se detallan a continuación:

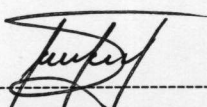
NOMBRE BIEN	CONTENIDO	RUTA ALMACENAMIENTO
Ítem N° 3: Un (01) software WinGLink para 1D y 2D (licencia por 03 años)	1. Setup.exe: archivo de instalación 2. Dongle: USB conteniendo la licencia (L-0324 Dongle S/N: K 01589)	H:\GEOFISICA\Softwares MT
Ítem N° 4: Un (01) software WSINV para 3D (Licencia por 01 año)	1. WSINV3DMT_v1XXX.tar: el código de serie. 2. WSINV3DMT_USER_MANUAL.PDF: el manual de usuario para el código de serie. 3. wsinv3dmt_mpi_easel_f77.tgz: el último código MPI 4. WSINV3DMT-MPI-new.PDF: manual del usuario para el código MPI	H:\GEOFISICA\Softwares MT

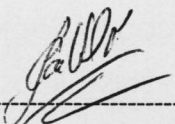
Siendo las 11:40 del día viernes 18 de marzo del 2022 se firma la presente acta en señal de conformidad de lo recibido de parte de la Agencia de Cooperación Internacional del Japón - JICA.

**Por la Dirección de Recursos
Minerales y Energéticos – DRME**

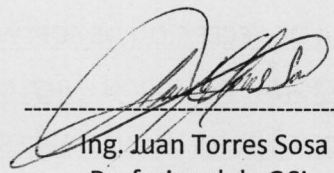

Ing. Jorge Chira Fernández
Director de la DRME

**Por la Oficina de Sistemas
de Información - OSI**


Ing. Luis Barranzuela Farfán
Director de OSI



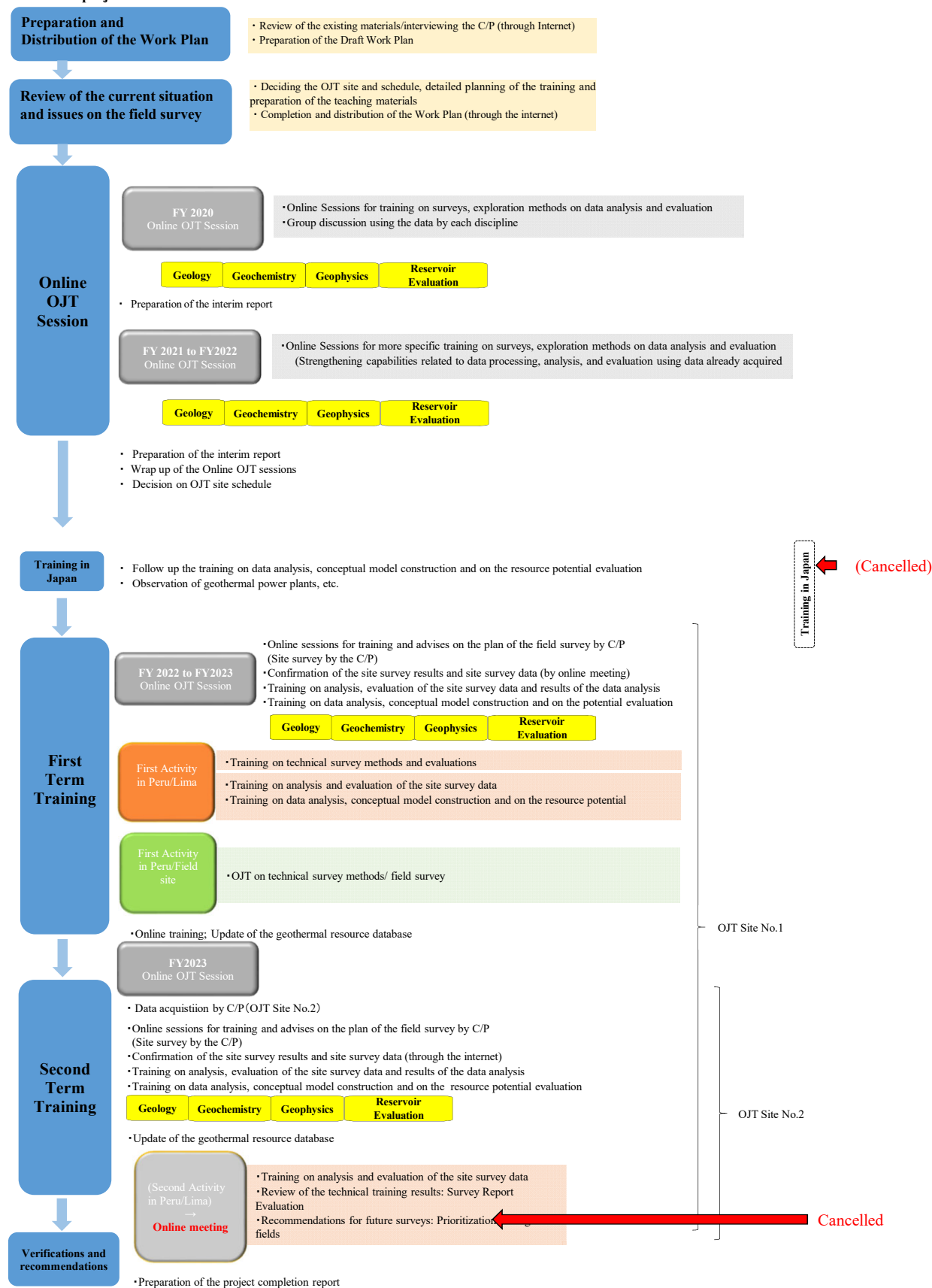
Ing. Carlos Valencia Miraval
Profesional de la DRME



Ing. Juan Torres Sosa
Profesional de OSI

Activities and Methods

Flow of the project



ANNEX 2

PDMs (All versions of PDM)

Project Design Matrix

Project Title : Project for Capacity Strengthening for Geothermal Resource Assessment

Organization : Geological, Mining and Metallurgical Institute: INGEMMET

Country : The Republic of Peru

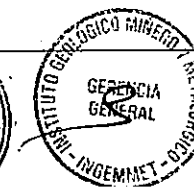
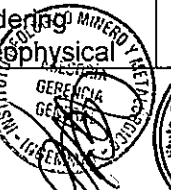
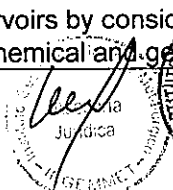
Target group : INGEMMET staff

Project period : 2020 to 2022 (for two and half years after arriving first JICA experts)

Date : November 2019

Version No.: PDM Ver.0

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Overall goal: Multiple discussion on the economic and social benefits and development potential of geothermal energy are held between INGEMMET, the government and private companies.	Accurate geothermal resource information based on the conceptual reservoir model is shared and discussed at the place where the government and private companies participate (Research report meeting for the government, seminars for private sector, INGEMMET website, academic society, etc).	Record by INGEMMET (INGEMMET keeps recording of the activities in relation with the indicator's requirements)	
Project purpose Capacity of INGEMMET to assess geothermal resources is strengthened.	- Conceptual geothermal reservoir model is developed more accurately based on new methodologies* and/or techniques introduced by the Project for geothermal resources assessment. - Number of reports produced on geothermal resources assessment is more than xx ** during the Project period. *The methodologies will be determined during the baseline survey. **The number of reports will be determined during the baseline survey.	- Project reports - Database of geothermal resources in Peru - Reports on geothermal resources	Policy on renewable energy resources are not changed in negative direction.
Outputs 1. Capacity of geological exploration to assess geothermal resources is strengthened.	1-1 INGEMMET officials can utilize remote sensing technologies for geological structure analysis. 1-2 INGEMMET officials can develop a conceptual geothermal model of geothermal reservoirs by considering geological, geochemical and geophysical	(Applied to all the Outputs) Project reports	INGEMMET officials who received technical transfer do not leave their positions related with geothermal resource assessment.



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2. Capacity of geochemical exploration to assess geothermal resources is strengthened.	data by themselves. 1-3 INGEMMET officials can specify drilling targets in consideration of the conceptual model.		
3. Capacity of analysis and interpretation of geophysical data such as gravity, geomagnetism, resistivity for geothermal resource assessment is strengthened.	2-1 INGEMMET officials can analyze major chemical components and stable isotope for interpretation of the origin of geothermal fluid by themselves. 2-2 INGEMMET officials can develop a conceptual geochemical model of geothermal reservoirs including the analysis of geochemical temperature by themselves.		
4. Capacity to assess potential of a geothermal reservoir is strengthened	3-1 INGEMMET officials can process and analyze the gravity data. 3-2 INGEMMET officials can process and analyze the geomagnetism data. 3-3 INGEMMET officials can process and analyze the resistivity data. 4-1 The database ¹ of geothermal resources is developed through integration of data on geology, geochemistry and geophysics. 4-2 INGEMMET officials can conduct preliminary numerical modeling of a geothermal reservoir and preliminary assessment of power potential by themselves.		

Activities

- 1-1 To select site(s) for training on geothermal resource exploration and assessment based on existing data, in accordance with annual working plan.
- 1-2 To conduct trainings on analysis and interpretation of geological structure and remote sensing data.
- 1-3 To conduct trainings on zoning of

Inputs

Japanese side

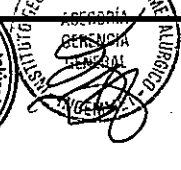
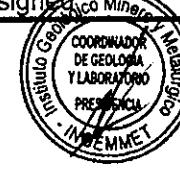
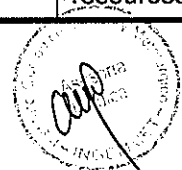
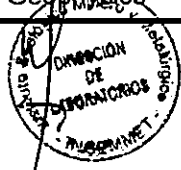
- 【Experts】
- Leader/Geothermal resource assessment
 - Geology
 - Geochemistry
 - Geophysics

Peru side

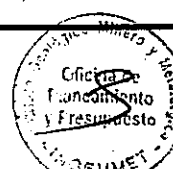
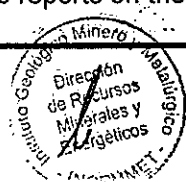
- 【Counterpart (C/P) arrangement】
- Project Director
 - Project Manager
 - Project Coordinator
 - Technical staff on geothermal resources assessment at

Precondition :

- OJT site is reserved.
- Necessary counterparts are assigned



hydrothermal alteration minerals. 1-4 To conduct trainings on dating. 1-5 To conduct trainings on fluid inclusion. 1-6 To conduct trainings on how to develop a conceptual geothermal model, which is based on geological, geochemical and geophysical exploration data. 1-7 To develop reports on geothermal resources. 2-1 To conduct trainings on analysis of major chemical components and isotopic ratio for the interpretation of the origin of geothermal fluid. 2-2 To conduct trainings on analysis of geochemical temperature of geothermal fluid. 2-3 To conduct trainings on how to develop conceptual geochemical model. 2-4 To develop reports on the geothermal resources. 3-1 To conduct trainings on gravity survey and magnetic exploration. 3-2 To conduct trainings on resistivity such as electrical exploration and electromagnetic exploration. 3-3 To conduct trainings on airborne geophysical exploration methods. 3-4 To develop reports on the geothermal resources. 4-1 To conduct trainings on development and management of database. 4-2 To conduct trainings on techniques which enable to improve the geothermal reservoir assessment and geothermal exploration. 4-3 To conduct trainings on techniques to identify and evaluate geothermal resources taking into account geological features in Peru. 4-4 To conduct trainings on how to assess potential of a geothermal reservoir. 4-5 To develop reports on the geothermal resources.	【Training】 • Training in Japan	INGEMMET 【Land, facility and equipment】 • Magnetotelluric • Office space at INGEMMET for the experts to work with counterparts • OJT site(s)	
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4-6 To update the existing INGEMMET database by uploading information and data obtained by the project activities.			
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Note: 1. The Project plans to update the existing database of geothermal resources at INGEMMET. New database development is not planned.



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Project Design Matrix

Project Title : Project for Capacity Strengthening for Geothermal Resource Assessment

Organization : Geological, Mining and Metallurgical Institute: INGEMMET

Country : The Republic of Peru

Target group : INGEMMET staff

Project period : 12 October 2020 to 11th April 2023

Date : December 2021

Version No.: PDM Ver.1

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
<u>Overall goal:</u> Multiple discussion on the economic and social benefits and development potential of geothermal energy are held between INGEMMET, the government and private companies.	Accurate geothermal resource information based on the conceptual reservoir model is shared and discussed at the place where the government and private companies participate (Research report meeting for the government, seminars for private sector, INGEMMET website, academic society, etc.).	Record by INGEMMET (INGEMMET keeps recording of the activities in relation with the indicator's requirements)	
<u>Project purpose</u> Capacity of INGEMMET to assess geothermal resources is strengthened.	1. Conceptual geothermal reservoir model is developed more accurately based on new methodologies* and/or techniques introduced by the Project for geothermal resources assessment. 2. Number of reports produced on geothermal resources assessment is more than xx ** during the Project period. *The methodologies will be determined during the baseline survey. **The number of reports will be determined during the baseline survey.	- Project reports - Database of geothermal resources in Peru - Reports on geothermal resources	Policy on renewable energy resources are not changed in negative direction.
<u>Outputs</u> 1. Capacity of geological exploration to assess geothermal resources is strengthened.	1-1 INGEMMET officials can utilize remote sensing technologies for geological structure analysis. 1-2 INGEMMET officials can develop a conceptual geothermal model of geothermal reservoirs by considering geological, geochemical and geophysical data by themselves.	(Applied to all the Outputs) Project reports	INGEMMET officials who received technical transfer do not leave their positions related with geothermal resource assessment.

2. Capacity of geochemical exploration to assess geothermal resources is strengthened. 3. Capacity of analysis and interpretation of geophysical data such as gravity, geomagnetism, resistivity for geothermal resource assessment is strengthened. 4. Capacity to assess potential of a geothermal reservoir is strengthened	1-3 INGEMMET officials can specify drilling targets in consideration of the conceptual model. 2-1 INGEMMET officials can analyze major chemical components and stable isotope for interpretation of the origin of geothermal fluid by themselves. 2-2 INGEMMET officials can develop a conceptual geochemical model of geothermal reservoirs including the analysis of geochemical temperature by themselves. 3-1 INGEMMET officials can process and analyze the gravity data. 3-2 INGEMMET officials can process and analyze the geomagnetism data. 3-3 INGEMMET officials can process and analyze the resistivity data. 4-1 The database¹ of geothermal resources is developed through integration of data on geology, geochemistry and geophysics. 4-3 INGEMMET officials can conduct preliminary numerical modeling of a geothermal reservoir and preliminary assessment of power potential by themselves.		
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Activities	Inputs		
	Japanese side	Peru side	
1-1 To select site(s) for training on geothermal resource exploration and assessment based on existing data, in accordance with annual working plan. 1-2 To conduct trainings on analysis and interpretation of geological structure and remote sensing data. 1-3 To conduct trainings on zoning of hydrothermal alteration minerals. 1-4 To conduct trainings on dating. 1-5 To conduct trainings on fluid inclusion. 1-6 To conduct trainings on how to develop a conceptual geothermal model, which is based on geological, geochemical and geophysical exploration data. 1-7 To develop reports on geothermal resources. 2-1 To conduct trainings on analysis of major chemical components and isotopic ratio for the interpretation of the origin of geothermal fluid. 2-2 To conduct trainings on analysis of geochemical temperature of geothermal fluid. 2-3 To conduct trainings on how to develop conceptual geochemical model. 2-4 To develop reports on the geothermal resources. 3-1 To conduct trainings on gravity survey and magnetic exploration. 3-2 To conduct trainings on resistivity such as electrical exploration and electromagnetic exploration. 3-3 To conduct trainings on airborne geophysical exploration methods. 3-4 To develop reports on the geothermal resources. 4-1 To conduct trainings on development and management of database.	【Experts】 • Leader/Geothermal resource assessment • Geology • Geochemistry • Geophysics 【Training】 • Training in Japan 【Equipment】 • WinGLink • WSINV3DMT • MT measurement equipment • Gas sampling equipment.	【Counterpart (C/P) arrangement】 • Project Director • Project Manager • Project Coordinator • Technical staff on geothermal resources assessment at INGEMMET 【Land, facility and equipment】 • Magnetotelluric • Office space at INGEMMET for the experts to work with counterparts • OJT site(s)	<u>Precondition :</u> • OJT site is reserved. • Necessary counterparts are assigned.

4-2 To conduct trainings on techniques which enable to improve the geothermal reservoir assessment and geothermal exploration. 4-3 To conduct trainings on techniques to identify and evaluate geothermal resources taking into account geological features in Peru. 4-4 To conduct trainings on how to assess potential of a geothermal reservoir. 4-5 To develop reports on the geothermal resources. 4-6 To update the existing INGEMMET database by uploading information and data obtained by the project activities.			
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Note: 1. The Project plans to update the existing database of geothermal resources at INGEMMET. New database development is not planned.

ANNEX 2-c: Revised PDM (Ver.2)

Project Monitoring Sheet I (Revision of Project Design Matrix)

Project Title: Project for Capacity Strengthening for Geothermal Resource Assessment
Implementing Agency: Geological, Mining and Metallurgical Institute: INGEMMET
Target Group: INGEMMET staff
Period of Project:2020 to 2023 (for two and half years after arriving first JICA experts)

Version 2
Dated March 2022

Project Site: The Republic of PeruModel Site: None					
Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption	Achievement	Remarks
Overall Goal Multiple discussion on the economic and social benefits and development potential of geothermal energy are held between INGEMMET, the government and private companies.	Accurate geothermal resource information based on the conceptual reservoir model is shared and discussed at the place where the government and private companies participate (Research report meeting for the government, seminars for private sector, INGEMMET website, academic society, etc.).	・ Record by INGEMMET (INGEMMET keeps recording of the activities in relation with the indicator's requirements)			This goal has not been achieved yet due to the project is still on going and is delayed due to the COVID-19 situation
Project Purpose Capacity of INGEMMET to assess geothermal resources is strengthened.	1. Conceptual geothermal reservoir model is developed more accurately based on new methodologies* and/or techniques introduced by the Project for geothermal resources assessment. 2. Number of reports produced on geothermal resources assessment is more than 4 during the Project period. *The methodologies will be determined during the baseline survey. **The number of reports will be determined during the baseline survey.	・ Project reports ・ Database of geothermal resources in Peru ・ Reports on geothermal resources	Policy on renewable energy resources are not changed in negative direction.	Capacity strengthening for geothermal resource assessment has been conducted online through technical lectures and discussion between INGEMMET and JICA experts. Yet to be achieved Yet to be achieved	1. The original program was affected by COVID-19 and forced the original plan for year 2020 to turn into remote training sessions 2. To the above, INGEMMET stated that not all personnel originally assigned to the project (mainly from DRME) had geothermal experience and that the remote training session should be at basic level to levelized the understanding among the trainees taking advantage that all the personnel had good command of own geoscientific background. 3. To take advantage of training session at basic level, INGEMMET requested, and JICA accepted, to allow more personnel of INGEMMET (DRME, DL and DGAR) to attend the training. 4. Activities for FY 2020 were at basic level and no attempt to develop a new conceptual model was done even using existing data 5. Remote training activities for FY 2021 were mostly stalled due to COVID-19 but were concentrated in the donation of equipment and in the installation of software in INGEMMET computing platform. Same as above Same as above
Outputs 1. Capacity of geological exploration to assess geothermal resources is strengthened.	1-1 INGEMMET officials can utilize remote sensing technologies for geological structure analysis. 1-2 INGEMMET officials can develop a conceptual geothermal model of geothermal reservoirs by considering geological, geochemical and geophysical data by themselves. 1-3 INGEMMET officials can specify drilling targets in consideration of the conceptual model.	(Applied to all the Outputs) ・ Project reports	INGEMMET officials who received technical transfer do not leave their positions related with geothermal resource assessment.	Capacity strengthening in geological exploration to assess geothermal resources is still ongoing. Exploration activities at a specific geothermal field are yet to be conducted pending to the selection and agreement between INGEMMET, the Consultant and JICA of the field where the OJT is going to be done. Yet to be achieved Yet to be achieved	(1) Activities for FY 2021 were at basic level and now being prepared to use existing data for training in data processing Same as (1) Same as (1)
2. Capacity of geochemical exploration to assess geothermal resources is strengthened.	2-1 INGEMMET officials can analyze major chemical components and stable isotope for interpretation of the origin of geothermal fluid by themselves. 2-2 INGEMMET officials can develop a conceptual geochemical model of geothermal reservoirs including the analysis of geochemical temperature by themselves.			Capacity strengthening in geochemical exploration to assess geothermal resources is still ongoing. Exploration activities at a specific geothermal field are yet to be conducted pending to the selection and agreement between INGEMMET, the Consultant and JICA of the field where the OJT is going to be done. Yet to be achieved	Same as (1) Same as (1)
3. Capacity of analysis and interpretation of geophysical data such as gravity, geomagnetism, resistivity for geothermal resource assessment is strengthened.	3-1 INGEMMET officials can process and analyze the gravity data. 3-2 INGEMMET officials can process and analyze the geomagnetism data. 3-3 INGEMMET officials can process and analyze the resistivity data.			Capacity strengthening in gravity and resistivity exploration to assess geothermal resources is still ongoing. Exploration activities at a specific geothermal field are yet to be conducted pending to the selection and agreement between INGEMMET, the Consultant and JICA of the field where the OJT is going to be done. Discontinued Yet to be achieved	Same as (1) Donation of equipment. The initial list of equipment and software to donate included magnetic exploration equipment. The consultant and JICA revisited the benefit of including geomagnetism in the training program and agreed to eliminate this component (training and donation) of the project. The approved for donation equipment and software was received and accepted by INGEMMET on March 18, Activities for FY 2021 were at basic level and most of the activities were dedicated to the donation of equipment. Also activities were done in the preparation of the use of existing data for training in the data processing.
4. Capacity to assess potential of a geothermal reservoir is strengthened.	4-1 The database of geothermal resources is developed through integration of data on geology, geochemistry and geophysics. 4-2 INGEMMET officials can conduct preliminary numerical modeling of a geothermal reservoir and preliminary assessment of power potential by themselves.			Data integration, conceptual modeling, data base and geothermal potential are objectives yet to be achieved. Yet to be achieved according to the remarks in the cell to the right	Same as (1) The wording of numerical modeling has to be changed to volumetric-stochastic potential evaluation because the data to be collected does not include well data and then the numerical simulation term is not applicable

Activities	Inputs		Important Assumption
	The Japanese Side	The Peru Side	
1-1 To select site(s) for training on geothermal resource exploration and assessment based on existing data, in accordance with annual working plan.	【Experts】 Chief Advisor /Reservoir assessment	【Counterpart (C/P) arrangement】 ・ Project Director	Keep checking in restriction for travelling to and from Peru and for travelers from Japan to return to Japan due to COVID-19
	Geologist A	・ Project Manager	
	Geologist B	・ Project Coordinator	
	Geologist C	・ Technical staff on geothermal resources assessment at INGEMMET	
	Geochemist A		
	Geochemist B		
	Geophysicist A	【Land, facility and equipment】 ・ Accessories of the old Magnetotelluric equipment to be used with the donated one.	
	Geophysicist B	・ Access and permits to the field OJT at the selected site.	
	Geophysics C/Admin	・ Office space at INGEMMET for the experts to work with counterparts	
	【Training】	・ OJT site(s)	
1-2 To conduct trainings on analysis and interpretation of geological structure and remote sensing data.	【Donation】 ・ WinGlink ・ WSINV3DMT	Donation ・ Hardware environment for the donated software to run ・ Continuation of WinGlink License after expiration of the initial 3 years license. ・ Storing and maintenance (including parts) to maintain the donated geophysical and replacement of the consumables included n the donated chemical equipment.	
1-3 To conduct trainings on zoning of hydrothermal alteration minerals.	・ MT measurement equipment ・ Gas sampling equipment (funnel, tubes, pumps, glass bottles, etc.)		
1-4 To conduct trainings on dating.			
1-5 To conduct trainings on fluid inclusion.			
1-6 To conduct trainings on how to develop a conceptual geothermal model, which is based on geological, geochemical and geophysical exploration data.			
1-7 To develop reports on geothermal resources.			
2-1 To conduct trainings on analysis of major chemical components and isotopic ratio for the interpretation of the origin of geothermal fluid.			
2-2 To conduct trainings on analysis of geochemical temperature of geothermal fluid.			
2-3 To conduct trainings on how to develop conceptual geochemical model.			
2-4 To develop reports on the geothermal resources.			
3-1 To conduct trainings on gravity survey and magnetic exploration.			
3-2 To conduct trainings on resistivity such as electrical exploration and electromagnetic exploration.			
3-3 To conduct trainings on airborne geophysical exploration methods.			
3-4 To develop reports on the geothermal resources.			
4-1 To conduct trainings on development and management of database.			
4-2 To conduct trainings on techniques which enable to improve the geothermal reservoir assessment and geothermal exploration.			
4-3 To conduct trainings on techniques to identify and evaluate geothermal resources taking into account geological features in Peru.			
4-4 To conduct trainings on how to assess potential of a geothermal reservoir.			
4-5 To develop reports on the geothermal resources.			
4-6 To update the existing INGEMMET database by uploading information and data obtained by the project activities.			

Note: 1. The Project plans to update the existing database of geothermal resources at INGEMMET. New database development is not planned.

Project Monitoring Sheet I (Revision of Project Design Matrix)

Project Title: Project for Capacity Strengthening for Geothermal Resource Assessment
Implementing Agency: Geological, Mining and Metallurgical Institute: INGEMMET
Target Group: INGEMMET staff
Period of Project:2020 to 2024 (for three years and eleven months)

ANNEX 2-d: Revised PDM
(Ver.3)

Version 3
Dated 24 November 2023

Project Site: The Republic of Peru	Model Site: Tutupaca				
Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption	Achievement	Remarks
Overall Goal Multiple discussion on the economic and social benefits and development potential of geothermal energy are held between INGEMMET, the government and private companies.	Accurate geothermal resource information based on the conceptual reservoir model is shared and discussed at the place where the government and private companies participate (Research report meeting for the government, seminars for private sector, INGEMMET website, academic society, etc.).	Record by INGEMMET (INGEMMET keeps recording of the activities in relation with the indicator's requirements)			This goal has not been achieved yet due to the project is still ongoing and is delayed due to the COVID-19 situation. The seminar is planned to be held in January 2024.
Project Purpose Capacity of INGEMMET to assess geothermal resources is strengthened.	1. Conceptual geothermal reservoir model is developed more accurately based on new methodologies* and/or techniques introduced by the Project for geothermal resources assessment. 2. Number of reports produced on geothermal resources assessment is more than 4 during the Project period. *The methodologies will be determined during the baseline survey. **The number of reports will be determined during the baseline survey.	Project reports Database of geothermal resources in Peru Reports on geothermal resources	Policy on renewable energy resources are not changed in negative direction.	Capacity strengthening for geothermal resource assessment has been conducted online through technical lectures and discussions between INGEMMET and JICA experts. In addition, JICA experts supervised INGEMMET personnel during fieldwork in Tutupaca field involving geologists, geochemists, and geophysicists. Report preparation is still ongoing.	1. The original program was affected by COVID-19 and forced the original plan for year 2020 to turn into remote training sessions 2. To the above, INGEMMET stated that not all personnel originally assigned to the project (mainly from DRME) had geothermal experience and that the remote training session should be at basic level to levelized the understanding among the trainees taking advantage that all the personnel had good command of own geoscientific background. 3. To take advantage of training session at basic level, INGEMMET requested, and JICA accepted, to allow more personnel of INGEMMET (DRME, DL and DGAR) to attend the training. 4. Activities for FY 2020 were at basic level and no attempt to develop a new conceptual model was done even using existing data 5. Remote training activities for FY 2021 were mostly stalled due to COVID-19 but were concentrated on the donation of equipment and in the installation of software in INGEMMET computing platform. 6. Field data acquisitions by INGEMMET have been done in Tutupaca from FY2022 to 2023 since COVID-19 situation had been relieved. 7. Online trainings for data analyses and interpretations have been done in FY2023. Same as above
Outputs 1. Capacity of geological exploration to assess geothermal resources is strengthened.	1-1 INGEMMET officials can utilize remote sensing technologies for geological structure analysis. 1-2 INGEMMET officials can develop a conceptual geothermal model of geothermal reservoirs by considering geological, geochemical and geophysical data by themselves. 1-3 INGEMMET officials can specify drilling targets in consideration of the conceptual model.	(Applied to all the Outputs) Project reports	INGEMMET officials who received technical transfer do not leave their positions related with geothermal resource assessment.	Capacity strengthening in geological exploration to assess geothermal resources is completed. INGEMMET, JICA experts and JICA agreed to select the Tutupaca field to be the location for OJT activity (geothermal exploration). Capacity strengthening in constructing a geothermal conceptual model is still ongoing. The discussion between geologists, geophysicists, and geochemists has been done with valuable input from INGEMMET personnel and JICA experts. Discussion on the conceptual model is still ongoing. The drilling target will be defined after agreed upon conceptual model.	1. Activities in FY 2022 and 2023 are at an advanced level including the structural analysis using DTM followed by validation by geological survey. Drilling target will be defined after agreed upon conceptual model.
2. Capacity of geochemical exploration to assess geothermal resources is strengthened.	2-1 INGEMMET officials can analyze major chemical components and stable isotope for interpretation of the origin of geothermal fluid by themselves. 2-2 INGEMMET officials can develop a conceptual geochemical model of geothermal reservoirs including the analysis of geochemical temperature by themselves.			Capacity strengthening in geochemical exploration to assess geothermal resources is still ongoing. INGEMMET, JICA experts and JICA agreed to select the Tutupaca field to be the location for OJT activity (geothermal exploration). Capacity strengthening in developing a conceptual geochemical model including the analysis of geochemical temperature is still ongoing.	
3. Capacity of analysis and interpretation of geophysical data such as gravity, geomagnetism, resistivity for geothermal resource assessment is strengthened.	3-1 INGEMMET officials can process and analyze the gravity data. 3-2 INGEMMET officials can process and analyze the geomagnetism data. 3-3 INGEMMET officials can process and analyze the resistivity data.			Capacity strengthening in gravity exploration to assess geothermal resources is still ongoing. INGEMMET, JICA experts and JICA agreed to select the Tutupaca field to be the location for OJT activity (geothermal exploration). Discontinued Capacity strengthening in processing and analyzing the resistivity data is completed. INGEMMET. Regarding the data analyses, 1D and 3D MT inversions were conducted by usinf the donated softwares. Additionally, INGEMMET personnel are able to conduct MT survey, processing and analysing by themself.	Donation of equipment. The initial list of equipment and software to donate included magnetic exploration equipment. JICA experts and JICA revisited the benefit of including geomagnetism in the training program and agreed to eliminate this component (training and donation) of the project. The approved for donation equipment and software was received and accepted by INGEMMET on March 18, 2022.
4. Capacity to assess potential of a geothermal reservoir is strengthened.	4-1 The database of geothermal resources is developed through integration of data on geology, geochemistry and geophysics. 4-2 INGEMMET officials can conduct preliminary numerical modeling of a geothermal reservoir and preliminary assessment of power potential by themselves.			Data integration, conceptual modeling, database and geothermal potential are still ongoing Preliminary assessment of power potential will be conducted after agree on conceptual model.	The location of OJT has no well data, therefore the numerical simulation cannot be conducted. However, preliminary assessment of power potential will be conducted using power density method and volumetric method with Monte Carlo analysis

Activities	Inputs		Important Assumption
	The Japanese Side	The Peru Side	
1-1 To select site(s) for training on geothermal resource exploration and assessment based on existing data, in accordance with annual working plan.	【Experts】 Chief Advisor /Reservoir assessment Geologist A Geologist B Geologist C Geochemist A Geochemist B Geochemist C Geophysicist A Geophysicist B Geophysics C/Admin	【Counterpart (C/P) arrangement】 ・ Project Director ・ Project Manager ・ Project Coordinator ・ Technical staff on geothermal resources assessment at INGEMMET 【Land, facility and equipment】 ・ Accessories of the old Magnetotelluric equipment to be used with the donated one. ・ Access and permits to the field OJT at the selected site. ・ Office space at INGEMMET for the experts to work with counterparts ・ OJT site(s)	
1-2 To conduct trainings on analysis and interpretation of geological structure and remote sensing data.	【Training】 【Donation】 ・ WinGlink ・ WSINV3DMT ・ MT measurement equipment ・ Gas sampling equipment (funnel, tubes, pumps, glass bottles, etc.)	【Donation】 ・ Hardware environment for the donated software to run ・ Continuation of WinGlink License after expiration of the initial 3 years license. ・ Storing and maintenance (including parts) to maintain the donated geophysical and replacement of the consumables included n the donated chemical equipment.	
1-3 To conduct trainings on zoning of hydrothermal alteration minerals.			
1-4 To conduct trainings on dating.			
1-5 To conduct trainings on fluid inclusion.			
1-6 To conduct trainings on how to develop a conceptual geothermal model, which is based on geological, geochemical and geophysical exploration data.			
1-7 To develop reports on geothermal resources.			
2-1 To conduct trainings on analysis of major chemical components and isotopic ratio for the interpretation of the origin of geothermal fluid.			
2-2 To conduct trainings on analysis of geochemical temperature of geothermal fluid.			
2-3 To conduct trainings on how to develop conceptual geochemical model.			
2-4 To develop reports on the geothermal resources.			
3-1 To conduct trainings on gravity survey and magnetic exploration.			
3-2 To conduct trainings on resistivity such as electrical exploration and electromagnetic exploration.			
3-3 To conduct trainings on airborne geophysical exploration methods.			
3-4 To develop reports on the geothermal resources.			
4-1 To conduct trainings on development and management of database.			
4-2 To conduct trainings on techniques which enable to improve the geothermal reservoir assessment and geothermal exploration.			
4-3 To conduct trainings on techniques to identify and evaluate geothermal resources taking into account geological features in Peru.			
4-4 To conduct trainings on how to assess potential of a geothermal reservoir.			
4-5 To develop reports on the geothermal resources.			
4-6 To update the existing INGEMMET database by uploading information and data obtained by the project activities.			

Note: 1. The Project plans to update the existing database of geothermal resources at INGEMMET. New database development is not planned.

ANNEX 2-c: Revised PDM (Ver.4)

Project Monitoring Sheet I (Revision of Project Design Matrix)

Project Title: Project for Capacity Strengthening for Geothermal Resource Assessment
Implementing Agency: Geological, Mining and Metallurgical Institute: INGEMMET
Target Group: INGEMMET staff
Period of Project:2020 to 2024 (for three years and eleven months)

Version 4
Dated 27 December 2023

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption	Achievement	Remarks
Overall Goal Multiple discussion on the economic and social benefits and development potential of geothermal energy are held between INGEMMET, the government and private companies.	Accurate geothermal resource information based on the conceptual reservoir model is shared and discussed at the place where the government and private companies participate (Research report meeting for the government, seminars for private sector, INGEMMET website, academic society, etc.).	· Record by INGEMMET (INGEMMET keeps recording of the activities in relation with the indicator's requirements)		Satisfactory improvement was achieved A preliminary geothermal assessment in Tutupaca field has been conducted. A discussion with the government and private sectors related to geothermal resources is planned to be held in 2024.	Based on the JCC meeting, the seminar will be held in the last week of January 2024.
Project Purpose Capacity of INGEMMET to assess geothermal resources is strengthened.	1. Conceptual geothermal reservoir model is developed more accurately based on new methodologies* and/or techniques introduced by the Project for geothermal resources assessment. 2. Number of reports produced on geothermal resources assessment is more than 4 during the Project period. *The methodologies will be determined during the baseline survey. **The number of reports will be determined during the baseline survey.	· Project reports · Database of geothermal resources in Peru · Reports on geothermal resources		Satisfactory improvement was achieved Capacity strengthening for geothermal resource assessment has been achieved through technical lectures and collaborated works between INGEMMET and JICA experts. In addition, JICA experts supervised INGEMMET personnel during the fieldwork in Tutupaca field involving geologists, geochemists, and geophysicists. A geothermal conceptual model of Tutupaca field has been constructed through the discussion among 3G geoscientists. Based on the conceptual model, a preliminary assessment of power potential has been conducted. Satisfactory improvement was achieved During the project, INGEMMET prepared the report under the supervision of JICA experts. JICA experts provided input back and forth to improve the quality of reports.	
Outputs					
1. Capacity of geological exploration to assess geothermal resources is strengthened.	1-1 INGEMMET officials can utilize remote sensing technologies for geological structure analysis. 1-2 INGEMMET officials can develop a conceptual geothermal model of geothermal reservoirs by considering geological, geochemical and geophysical data by themselves. 1-3 INGEMMET officials can specify drilling targets in consideration of the conceptual model.	(Applied to all the Outputs) · Project reports		Satisfactory improvement was achieved Capacity strengthening in geological exploration to assess geothermal resources is completed. INGEMMET, JICA experts and JICA agreed to select the Tutupaca field to be the location for OJT activity (geothermal exploration). Satisfactory improvement was achieved Capacity strengthening in constructing a geothermal conceptual model is conducted. The discussion between geologists, geophysicists, and geochemists has been done with valuable input from INGEMMET personnel and JICA experts. Satisfactory improvement was achieved Discussion on the conceptual model is conducted. The online lecture related to the drilling target has been conducted. However, the INGEMMET team still needs to do the actual drilling target selection by themselves.	
2. Capacity of geochemical exploration to assess geothermal resources is strengthened.	2-1 INGEMMET officials can analyze major chemical components and stable isotope for interpretation of the origin of geothermal fluid by themselves. 2-2 INGEMMET officials can develop a conceptual geochemical model of geothermal reservoirs including the analysis of geochemical temperature by themselves.			Satisfactory improvement was achieved Capacity strengthening in geochemical exploration to assess geothermal resources is completed. Geochemical study in Tutupaca by INGEMMET has been done with proper interpretations and they were summarized in a report. Satisfactory improvement was achieved Capacity strengthening in developing a conceptual geochemical model including the analysis of geochemical temperature is in the final stage.	
3. Capacity of analysis and interpretation of geophysical data such as gravity, geomagnetism, resistivity for geothermal resource assessment is strengthened.	3-1 INGEMMET officials can process and analyze the gravity data. 3-2 INGEMMET officials can process and analyze the geomagnetism data. 3-3 INGEMMET officials can process and analyze the resistivity data.			Satisfactory improvement was achieved Capacity strengthening in gravity exploration to assess geothermal resources is conducted. INGEMMET, JICA experts and JICA agreed to select the Tutupaca field to be the location for OJT activity (geothermal exploration). It is decided that processing and analyzing the geomagnetism data is out of scope based on the agreement by both parties. Remarkable improvement was achieved Capacity strengthening in processing and analyzing the resistivity data is completed. Regarding the data analyses, 1D and 3D MT inversions were conducted by using the donated software. Additionally, INGEMMET personnel are able to conduct MT surveys, processing and analyzing by themself.	
4. Capacity to assess potential of a geothermal reservoir is strengthened.	4-1 The database of geothermal resources is developed through integration of data on geology, geochemistry and geophysics. 4-2 INGEMMET officials can conduct preliminary numerical modeling of a geothermal reservoir and preliminary assessment of power potential by themselves.			Satisfactory improvement was achieved Data set of 3G studies and reservoir engineering to be stored in the database has been prepared such as geological maps, diagrams of geochemistry, geophysical maps, conceptual model, resource assessment etc. Satisfactory improvement was achieved A preliminary assessment of power potential has been conducted based on the conceptual model.	

Activities	Inputs		Important Assumption
	The Japanese Side	The Peru Side	
1-1 To select site(s) for training on geothermal resource exploration and assessment based on existing data, in accordance with annual working plan.	【Experts】 Chief Advisor /Reservoir assessment	【Counterpart (C/P) arrangement】 ・ Project Director	
	Geologist A	・ Project Manager	
	Geologist B	・ Project Coordinator	
	Geologist C		
	Geochemist A	・ Technical staff on geothermal resources assessment at INGEMMET	
	Geochemist B		
	Geochemist C	【Land, facility and equipment】 ・ Accessories of the old Magnetotelluric equipment to be used with the donated one.	
	Geophysicist A	・ Access and permits to the field OJT at the selected site.	
	Geophysicist B	・ Office space at INGEMMET for the experts to work with counterparts	
	Geophysics C/Admin	・ OJT site(s)	
1-2 To conduct trainings on analysis and interpretation of geological structure and remote sensing data.	【Training】 【Donation】 ・ WinGlink ・ WSINV3DMT ・ MT measurement equipment ・ Gas sampling equipment (funnel, tubes, pumps, glass bottles, etc.)	【Donation】 ・ Hardware environment for the donated software to run ・ Continuation of WinGlink License after expiration of the initial 3 years license. ・ Storing and maintenance (including parts) to maintain the donated geophysical and replacement of the consumables included n the donated chemical equipment.	
1-3 To conduct trainings on zoning of hydrothermal alteration minerals.			
1-4 To conduct trainings on dating.			
1-5 To conduct trainings on fluid inclusion.			
1-6 To conduct trainings on how to develop a conceptual geothermal model, which is based on geological, geochemical and geophysical exploration data.			
1-7 To develop reports on geothermal resources.			
2-1 To conduct trainings on analysis of major chemical components and isotopic ratio for the interpretation of the origin of geothermal fluid.			
2-2 To conduct trainings on analysis of geochemical temperature of geothermal fluid.			
2-3 To conduct trainings on how to develop conceptual geochemical model.			
2-4 To develop reports on the geothermal resources.			
3-1 To conduct trainings on gravity survey and magnetic exploration.			
3-2 To conduct trainings on resistivity such as electrical exploration and electromagnetic exploration.			
3-3 To conduct trainings on airborne geophysical exploration methods.			
3-4 To develop reports on the geothermal resources.			
4-1 To conduct trainings on development and management of database.			
4-2 To conduct trainings on techniques which enable to improve the geothermal reservoir assessment and geothermal exploration.			
4-3 To conduct trainings on techniques to identify and evaluate geothermal resources taking into account geological features in Peru.			
4-4 To conduct trainings on how to assess potential of a geothermal reservoir.			
4-5 To develop reports on the geothermal resources.			
4-6 To update the existing INGEMMET database by uploading information and data obtained by the project activities.			

Note: 1. The Project plans to update the existing database of geothermal resources at INGEMMET. New database development is not planned.