

**SECRETARIAT
INTERNATIONAL CONFERENCE
ON THE GREAT LAKES REGION**



**SECRÉTARIAT
CONFÉRENCE INTERNATIONALE
SUR LA RÉGION DES GRANDS LACS**

ICGLR REPORT ON THE STATUS OF BGR/ICGLR PROJECT ON AFP

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Abbreviations

AC	Air Condition
AFP	Analytical Fingerprint
AMGC	African Minerals and Geosciences Centre
AMU	Analytical Fingerprint Management Unit
BMZ	German Federal Institute for Economic Cooperation and Development
GMD	Geology and Mines Department (now RMB)
ICGLR	International Conference on the Great Lakes Region
ICPMS	Inductively Coupled Plasma - Mass Spectrometer
LA	Laser Ablation
LAICPMS	Laser Ablation Inductively Coupled Plasma - Mass Spectrometer
OBM	Office Burundais des Mines et Carrières
RCM	Regional Certification Mechanism
RMB	Rwanda Mines, Petroleum and Gas Board
SEAMIC	Southern and Eastern African Mineral Centre (now AMGC)
SEM	Scanning Electron Microscope
SGN-C	Service Géologique National du Congo
TIMA	TESCAN Integrated Minerals Analyzer
UPS	Uninterruptible Power Supply



1. INTRODUCTION

1.1 Background

The International Conference on the Great Lakes Region (ICGLR) has set up the Regional Initiative against the Illegal Exploitation of Natural Resources in order to mitigate conflicts and war fueled by the illegal exploitation and trade of natural resources, hence, to allow the mining sector of the region flourishing and contributing to the economic expansion of the region and the well-being of its population. The Regional Certification Mechanism (RCM), one of the main tools of the Initiative, acts on the upstream stakeholders of the mineral supply chain, that is from the origin mine site to the export point and intends to ensure the minerals entering the supply chain are conflict-free and the exploitation and trade of the minerals being in line with existing due diligence measures at international level. ICGLR RINR relies also on its control measures put in place to enhance its credibility and to allow the mineral production of the region to have access to the international market.

The Analytical Fingerprint method (AFP) was developed between 2006 and 2009 by the German Federal Institute on Geosciences and Natural Resources (BGR). Funded by the German Ministry for Economic Cooperation and Development (BMZ) and implemented by BGR, an AFP project was introduced into the RCM as part of the overall regional German cooperation framework with ICGLR through the program “Promotion of Transparency in the mineral supply chain in the Great Lakes Region”.

The integration of AFP technology in ICGLR RINR Regional Certification Mechanism was approved by the ICGLR RIMC in Kampala 2011 with the establishment of the AFP analytical laboratory at AMGC-African Minerals and Geosciences Centre (former SEAMIC-Southern and Eastern Africa Mineral Centre) in Dar es Salaam, Tanzania including the AFP sample preparation laboratories in the implementing countries as well as the AFP Management Unit (AMU) embedded in ICGLR’s Natural Resources Unit within the Programme on Democracy and Good Governance at the ICGLR Headquarters in Bujumbura. The AFP technology has been implemented in Burundi, Democratic Republic of Congo (DRC), Rwanda and Tanzania and was intended to be extended in other ICGLR Member States, particularly 3T minerals producers such as Uganda.

1.2 The objectives of BGR/ICGLR project and AFP technology

The development of the AFP technology at the German Federal Institute for Geosciences and Natural Resources (BGR) began around 2008 as a research project.

The concept to integrate the AFP into the Regional Certification Mechanism (RCM) was developed when the German Federal Ministry for Economic Cooperation and Development (BMZ) initiated its support to the International Conference on the Great Lakes Region (ICGLR), in particular with regards to the Regional Certification Mechanism (RCM) implementation.



The objectives of the project, which has been continuously extended ever since, were to further develop the AFP technology, establish a laboratory infrastructure and train local staff as a basis to establish the application of AFP within RCM process. The current project phase ends by 31 December 2024 with the handover of the project to the ICGLR.

This document represents an in-depth analysis report on the status of the Analytical Fingerprint project. That means, it will give an overview on the implementation status of individual aspects of AFP as well as background information and an outlook concerning activities making part of the process of handover of AFP envisaged for second half of 2024.

2. AFP ENTITIES

The application of AFP requires a certain infrastructure which was established in the Great Lakes region since 2011 and comprises 3 sample preparation laboratories of which 2 are operational, an AFP analytical laboratory and the Analytical Fingerprint Management Unit (AMU).

2.1 AFP sample preparation laboratories

AFP sample preparation laboratories were established in Kigali (Rwanda) in 2013, Bujumbura (Burundi) in 2014 and Bukavu (DRC) in 2014. Their purpose is to provide ICGLR and Member States with the means to prepare so-called polished sections, i.e. loose grains of 3T concentrate in hardened epoxy that are turned into cylinders with a polished surface of one inch diameter as a prerequisite for subsequent analyses. The sample preparation laboratories also contain equipment that allows the preparation of thin sections to expand the use of the laboratories for applications beyond the AFP.

The equipment of sample preparation laboratories is the property of ICGLR, but they are operated by national partners of implementing Member States in charge of geology, mining etc. In Burundi, this is the Office Burundais des Mines (OBM) while in DRC, the SGN-C (Service Géologique National – Congo) is managing the sample preparation laboratory. The sample preparation laboratory in Rwanda was operational until 2016 and managed by GMD (Geology and Mines Department, later reorganised to RMB). Since 2016, when RMB was moving into new premises and the building hosting the laboratory was demolished, the sample preparation laboratory is not operational, and the equipment is not being used. It was agreed in 2023 between ICGLR, RMB and DGSM that the equipment of the sample preparation laboratory in Rwanda should be relocated to Uganda to set up an AFP sample preparation laboratory in Entebbe. BGR committed to cover the costs for relocation.

Another sample preparation laboratory to prepare AFP-unrelated samples was established at AMGC to allow the preparation of samples for AFP-unrelated analyses.



The equipment of these laboratories is for the most parts the same but individual inventory lists per laboratory will be prepared for the handover.

An inventory list of the equipment of the sample preparation laboratories can be found in Table 1 below.

Table 1: Inventory list of most relevant equipment in sample preparation laboratories

Item	Manufacturer, Model	Price in EUR as of 2018; without VAT
Rock saw	Uniprec Woco 50 FU	8,170
Semi-automatic grinding and polishing machine	Bühler EcoMet 250 Pro Grinder- Polisher	14,603
Thin section grinding and polishing machine	PetroThin Thin Sectioning System	18,809
Epoxy impregnation chamber	Cast n'Vac 1000	3,723
compressor	Planet Line 120-25	1,383
Heating cabinet	Memmert	842
Polarisation microscope	Leica DMT750P LED	7,594
Thin section bonding tool	PetroBond	3,878
Ultrasonic bath	RK52	594
	Total	59,596

2.2 AFP analytical laboratory

After their preparation, polished sections of 3T concentrates need to be analysed. For this purpose, an analytical laboratory was established at the African Minerals and Geosciences Centre (AMGC) in Dar es Salaam, Tanzania. The Centre was chosen as a hosting institution of the laboratory after a detailed identification process which concluded that AMGC (then SEAMIC) would be the most suitable partner. A detailed identification report was presented by BGR to the ICGLR Regional Committee against the illegal exploitation of natural resources in April 2011 which approved AMGC as the host and subsequently adopted by the RIMC meeting held in December 2011 in Kampala, Uganda.

The most significant criteria were that SEAMIC/AMGC had the capabilities in terms skilled staff and administrative procedures to operate the analytical laboratory on behalf of ICGLR and its location in Tanzania made it stand out as a “neutral ground” in the highly politicised 3T sector. The location in Dar es Salaam was also advantageous with respect to its reliable supply with analytical gases.

From 2013-2016, the premises at AMGC identified to host the AFP laboratory were completely refurbished to adhere to international standards. In a subsequent building phase in 2019, the roof was completely renovated and equipped with a 30 kV

photovoltaic system. Challenges by the local climate and power issues were considered and the infrastructure established now comprises:

1. Central automatic air conditioning
2. 40 kVA uninterruptible power supply
3. Back-up diesel generator
4. 1000 litres diesel tank
5. 30 kV photovoltaic system and solar batteries
6. Analytical gas supply pipe system

Concerning analytical instruments, the laboratory was equipped in 2017 with a **Scanning Electron Microscope (SEM) from TESCAN, Modell Tescan Integrated Mineral Analyser (TIMA)** equipped with a Back-scattered Electron (BSE) and a Secondary Electron (SE) detector. The instrument is a very cost-effective analytical machine and is equipped with a software for automated mineralogy which is used for AFP. However, it can be used for various other analytical applications which are described in chapter 5.3 in context with potential commercial use of the lab equipment.



Fig. 1: TESCAN TIMA installed at the AFP analytical laboratory at AMGC, Dar es Salaam, Tanzania

In the same year an **ICP-MS, an AGILENT 7900**, and a **Laser Ablation (LA) instrument from New Wave Research (NWR213)** were installed in the laboratory. Both instruments combined form the LA-ICPMS system essential for AFP.

The ICP-MS can theoretically be used for many other applications such as water, soil and rock analysis for major and trace elements. However, nearly all applications



Fig. 2: Laser Ablation (LA) system (left) and ICP-MS (right) in the AFP analytical laboratory at AMGC, Dar es Salaam, Tanzania



except water analysis require a distinct step of chemical sample preparation including acid digestion, dilution with ultra-high-pure acids and/or distilled water etc. with which the AFP laboratory is not equipped. AMGC also does not possess the necessary premises which leaves for now the analysis of water samples that only need to be diluted.

A note of consent for construction works of new premises for the chemical sample preparation laboratory was co-signed by BGR and AMGC in February 2022 and endorsed by ICGLR but was never materialized by BGR.

2.3 Analytical Fingerprint Management Unit (AMU) and AFP Database

The Analytical Fingerprint Management Unit (AMU) forms part of the Natural Resources Unit of the ICGLR and is the central entity overseeing all AFP processes. The AMU also hosts the AFP database which contains analytical datasets and related metadata of AFP samples taken during reference sampling campaigns or for development of AFP statistical evaluation methods. Currently, the AMU consists of four employees: a Head of Unit, a data analyst, a logistician and an accountant.

3. COSTS

There are several different origins of costs arising from any AFP application which are:

1. sampling and sample preparation
2. analysis
3. data evaluation
4. administration

which can be affiliated to the following entities of the AFP per status quo:

1. Sample preparation laboratories in Member States (sampling and sample preparation)
2. AFP analytical laboratory at AMGC (analysis)
3. AMU at ICGLR Secretariat (data evaluation and administration)

In total, the **operating costs for the AFP as per the status quo is estimated at €463,689/year** which does not include activities such as sampling campaigns.

The breakdown of the costs for each of the AFP entities is presented in the tables below while a detailed breakdown for the analytical laboratory can be found in Annex 1.



3.1 Sample preparation laboratories.

The running costs for each of the four sample preparation laboratories were calculated as follows:

Table 2: Example running costs of the three AFP sample preparation laboratories and the sample preparation laboratory at the analytical laboratory at AMGC; costs for staff not included

Item	Per sample preparation laboratory [EUR]	All sample preparation laboratories [EUR]
Depreciation equipment (10% of equipment cost upon purchase)	5,960	23,840
Consumables (estimate)	1,000	4,000
Water, electricity (estimate)	1,000	4,000
Miscellaneous (estimate)	1,000	4,000
	Total¹	35,840

3.2 AFP analytical laboratory

Expenditures at the AFP analytical laboratory at AMGC in Dar es Salaam comprise:

1. Depreciation and service contracts for analytical equipment. This applies for the SEM, the Laser Ablation system, the Mass Spectrometer, and the equipment for sample preparation (depreciation only).
2. Service contracts for the infrastructure, i.e. the diesel generator, the air conditioning, and the photovoltaic system.
3. Analytical gases, the number portrayed below represents the cost estimate of 75 AFP analyses per year.
4. Operating costs, i.e., costs for diesel, salaries for AMGC staff, utilities, compliance, car, and fuel, clearing fees as well as a “miscellaneous” amount.

Table 3: Estimated Annual Expenditure at the AFP Analytical Laboratory in EUR

Item/device	Annual costs [EUR]
SEM	103,595
Laser Ablation	29,000
Mass Spectrometer	48,420
Sample preparation	8,960

¹ Each sample preparation laboratory has its own cost structure. However, since the equipment in all is comparable, the numbers portrayed here might serve as a basis for discussion.



Generator, AC, PV system	5,577
Analytical gases ²	47,580
Operating costs	44,493
Total	287,626

3.3 The Analytical Management Unit (AMU)

Costs for running the AMU comprise salaries of the AMU staff and a budget for the AMU office, including maintenance of the AFP database of 1.000€/month, 12 travels per year for 1.500€ each and annual expenses for one car comprised of 10.000€ for depreciation and 5.000€ for diesel, insurance, repairs, etc.

Table 4: Estimated Annual Expenditure for AMU

Item	Annual costs [EUR]
Staff salaries	95,223
Office supplies	12,000
Travels	18,000
Car maintenance and Depreciation	15,000
Total	140,223

4. ACHIEVEMENTS AND CHALLENGES

4.1 AFP methods and processes

The AFP methodology as described in the 3rd Edition of the AFP Manual was to apply the AFP from the mine sites to the export points. The methodology was refined following questions raised by stakeholders on the application of AFP on complex mineral supply chains and mixed concentrates, this led to the revision of the AFP manual (4th Edition).

In view of the above, a project log frame of 2018 revised in 2020 was tailored to allowing the application of AFP on various mineral supply chain scenarios. The log frame included promotional activities for increasing requests for AFP application in line with the supply chain scenarios. Unfortunately, the 2018 log frame planned activities never got implemented except those related to scientific publications by BGR.

² Estimate for 75 AFP analyses per year



4.2 Sampling, analysis and database

Sampling was continuously conducted in Burundi, DRC and Rwanda. Reference samples are AFP samples taken on the mine sites according to specific standards in order to assure credibility concerning their origin from the respective mine sites while control samples are samples taken from the supply chain for comparing them to the reference samples taken from the origin mine sites of the concerned mineral supply chain. Control sampling had been conducted mostly for reasons of method development and AFP applications.

Table 5: Overview of AFP samples taken as of March 2024

Country	Reference Samples	Mine sites	Control Samples	Sampling sites (Storage/Comptoir)
Rwanda	563	339	16	11
DRC	566	300	26	20
Burundi	166	79	41	35
Uganda	10	1	2	0
TOTAL	1305	719	85	66

Throughout the project period under review, the AFP database managed by the AMU at the ICGLR Secretariat is hosting data from the following fully analysed samples:

Table 6: Overview of AFP reference and control samples for which mineralogical and geochemical data is stored in the AFP Database

Country	Reference samples	Control samples
Rwanda	311	9
DRC	72	0
Burundi	41	4
Total	424	13

Until finalisation of the development of the methodology for statistical evaluation of the AFP method, many reference samples were analysed and mineralogical data were shared with Member States because these might be of use for miners and relevant government institutions. The geochemical data of many samples are yet to be made available. As these samples are the properties of the Member States and miners, it is imperative to complete the analysis of all the samples and submit the analysis results to Member States for use.



4.3 AFP laboratory infrastructure

The laboratory infrastructure as described in chapter 2 was successfully established but there is the ICP-MS equipment that encountered a technical problem and needs to be repaired. The ICGLR and relevant national institutions were provided with the framework and means (installation and capacity building) to perform AFP from sampling to sample preparation and to analysis as well as data evaluation. Unfortunately, the Analytical laboratory has never generated geochemical data from the ICP-MS machine installed, and most trained staff of AMGC on AFP have left to new work options and causes of the high staff turnover needs to be elucidated.

4.4 Trainings

Training was performed or facilitated by BGR concerning AFP sampling and sample preparation (polished sections and thin sections), AFP analyses (SEM analysis, LA-ICPMS analysis) and AFP data evaluation.

4.4.1 Sampling and sample preparation

Training on AFP sampling was done at the beginning of the project by BGR team and later on predominantly by the AMU and officers from national partners. The training on sample preparation has been extended to 1 or 2 more staff in order to ensure continuity in case the responsible of the laboratories are not available.

Training on the preparation of polished and thin sections was also done at the beginning of the project by BGR experts with some technicians having been trained at BGR HQ, Hannover in Germany. During the project, the training format was changed into a peer-learning approach based on the capacities of staff already trained. All operational sample preparation laboratories have the capacities to produce polished sections for AFP and skilled staff to conduct AFP sampling.

4.4.2 AFP analyses: SEM and LA-ICPMS analysis

Training for the analytical laboratory was performed by BGR between 2014 and 2022 for several staff members of AMGC. In 2023 and 2024, training was extended to officers of the Geological Survey of Tanzania (GST) and those of the Tanzania Mining Commission (TMC) to stabilise staffing for the AFP analytical laboratory at AMGC.



Table 7: Trainings on AFP analytical instruments from September 2014 to March 2024

Date	Trainee(s)	Trainer	Location	Training
Sep 2014	John Bomani	Dr. Eike Gäbler (BGR)	Hannover	sample preparation, SEM, LA-ICPMS
May 2016	Lilian Moshi, Imelda Luumi	Dr. Eike Gäbler (BGR)	Hannover	sample preparation, SEM, LA-ICPMS
Jul 2017 - Feb 2020	Lilian Moshi, Charles Buteta	Timo Gawronski (BGR)	AMGC	sample preparation, SEM, LA-ICPMS
Feb 2022	Michael Clovis, Juma Rajabu	Timo Gawronski	AMGC	SEM, LA-ICPMS
May 2022	Michael Clovis, Juma Rajabu	Timo Gawronski	AMGC	SEM, LA-ICPMS
Jul 2022	Michael Clovis, Juma Rajabu	Timo Gawronski	AMGC	SEM
Sep- Oct 2022	Michael Clovis, Juma Rajabu	Timo Gawronski	AMGC	SEM
Oct 2023	Hassan Makonde (AMGC), Charles Buteta (AMGC), Kamana Karikela (GST), Zaituni Issere (GST), Hassan Kodema (Tanzania Mining Commission, TMC), David Lyandala (TMC)	Manuel Grobelaar (WIRSAM Scientific), Lukas Iwan (BGR)	AMGC	SEM basic user training
04-08 March 2024	Hassan Makonde (AMGC), Charles Buteta (AMGC), Kamana Karikela (GST), Zaituni Issere (GST), Hassan Kodema (Tanzania Mining Commission, TMC), David Lyandala (TMC)	Augustin Byamungu (AFP sample preparation Bukavu), Lukas Iwan (BGR)	AMGC	SEM training and sample preparation

Training had to be restarted twice (February 2022 and October 2023) because staff trained by BGR on AFP analysis left AMGC. In October 2023, training had to be restarted and as a lesson from previous experience also included trainees from relevant Tanzania institutions, namely the Geological Survey Tanzania (GST) and the Tanzania



Mining Commission (TMC). An external trainer provided by the manufacturer of the machine conducted an introductory training on the SEM for 2 AMGC staff and 4 staff from the Government of Tanzania (GST). The training will be continued with another training on applications and software and will be facilitated by BGR.

At the time of drafting this report, the capacities to analyse AFP samples at the AFP analytical laboratory are not sufficient. This has led to the inability to confirm the functionality of the analytical laboratory equipment installed at AMGC, especially the ICP-MS machine.

4.4.3 AFP data evaluation

Continuous ad-hoc training of the AMU data analyst was performed by BGR in Germany and in the region. Hence, the AMU has the capabilities to perform the statistical evaluation of AFP and to manage the AFP database.

4.5 Integration of the AFP into RCM components

The AFP is integrated into the Regional Certification Mechanism as an “Analytical Mineral Determination (AMD)” technology which is defined in the RCM Manual (Second Edition) as “A combination of scientific techniques, which might be used as an additional tool to assist with the determination of the origin of Designated Minerals. AMD is applicable to all Designated Minerals, where technological solutions exist. Analytical Fingerprint (AFP) is a form of AMD for tantalum, tin and tungsten”.

4.5.1. The AFP reference in the Regional Certification Mechanism

The AMD – and thus the AFP – is sufficiently referred to in the RCM Manual – 2nd Edition:

- a) Paragraph 2.18. Upon request by the ICGLR or Member State, allow Analytical Mineral Determination (AMD) sampling of Designated Minerals at all stages of the supply chain.
- b) Paragraph 33.1 Upon request by an RCM Actor, apply AMD techniques to assist in the determination of the origin of the Designated Minerals.
- c) Appendix A - Table 4: 6. The mine owner or operator refuses to allow Analytical Mineral Determination (AMD) sampling to the ICGLR or Member State.
- d) Appendix A - Table 6: 4. The Mine Site Owner or Operator refuses to provide sample material for an Analytical Mineral Determination (AMD) sampling to the ICGLR or Member State.



- e) Appendix E - Table 8: - 6. Any supply chain actor in the Exporter's supply chain refuses to allow Analytical Mineral Determination (AMD) sampling to be conducted by the ICGLR or Member State.

Although all these paragraphs are clear with regards to who can request AFP and how, for instance, the refusal to facilitate the AFP sampling would reflect in the mine site inspection or audit result, the role of the Member States in the AFP application process is unclear.

The integration of the AFP into ICGLR Third Party Audits was discussed during the ICGLR Audit Committee meeting in April 2023 and the roadmap for AFP integration in Third Party Audits was adopted by the committee as pilot phase which will be evaluated after 2 years of implementation. The integration of the AFP as a mandatory analysis during Third-party audits is not provided for in the RCM Manual.

4.5.2. Use and Benefits of AFP to the mineral supply chain actors.

There are two categories of benefits:

- (1) In the framework of the Regional Initiative on Natural Resources (RINR):
 - to guarantee the responsible mineral supply chain and the existing CoC system: (i) where the method can be used by national mining institutions or independent mineral supply actors based on CoC evaluation, (ii) by mining companies or their customers for positive proof.
 - also, as a complementary tool for mineral supply risk assessment: (i) ICGLR Third Party Audits by auditors based on document review or mine site visit findings, (ii) by Audit Committee based on audit reports, (iii) by auditees in appeal procedures.
- (2) Non RINR benefits to mining companies, national mining institutions and research institutions:
 - the mineralogical data produced can be used by Member States in order: (i) to acquire a better understanding of the distribution of valuable minerals (for example potentials for niobium commonly abundant in coltan with a value of about 60% more than that of tantalum; Coltan is only one of several minerals that may contain tantalum. Some few mine sites in the Great Lakes Region contain for example the tantalum-bearing mineral microlite (sometimes referred to as "white coltan") as the main tantalum phase) or (ii) potentially dangerous, i.e., radioactive minerals such as thorium, uranium, or heavy metals, within the country.
 - the mineralogical information can be used for exploration, price negotiation, taxation, occupational health, and safety (OHS) and environmental risk mitigation. The equipment of the AFP sample preparation laboratories can be



used for other purposes, for example the preparation of thin sections and polished sections used for mineralogical analysis and petrography.

4.6 Challenges

4.6.1 Technical

One critical issue for the future is that the ICP-MS machine has never analysed the samples since it has been installed. The second issue is the long downtime of analytical equipment due to long waiting time for repairs or shipment of necessary spare parts. Maintenance and service companies do not reside in the region and service technicians, or spare parts must fly in from Europe or South Africa. This is, however, a common problem for analytical laboratories all over the world.

Nevertheless, it was agreed between ICGLR and BGR in 2012 that, to facilitate the maintenance of the laboratory equipment, the equipment, and its installations at AMGC should be exactly the same as those at BGR Headquarters in Hannover, which is not the case.

4.6.2 Training

During the lifetime of the project, several staff in particular at the sample preparation laboratories and the analytical laboratory have been trained on AFP processes such as sampling, sample preparation and analysis. Whenever trained staff left the AMGC because of new work options, training had to start again from the beginning with a recruitment process for new staff. This was in particular the case at the analytical laboratory where a high departure rate of staff was observed over the years.

4.6.3 Application of AFP

Despite the low understanding of the AFP technology by the public and private mining actors due to the lack of sensitization sessions as it was noted in the 2018 project logic framework, there are records of requests of AFP application by Member States and mineral supply chain actors.

In addition, it is worth noting that the AFP requests can only be processed at the AFP analytical laboratory at AMGC if skilled and trained staff is on duty and, more important, if the AFP laboratory can perform a complete sample analysis. Currently, the AFP analytical laboratory only provides mineralogical data while the ICP-MS machine never performed geochemical analysis.

4.6.4 Costs

Currently, the operating costs of the whole AFP project are estimated at around €470.000/year. On the other side, the sustainability will depend on the operationalization the analytical and sample preparation laboratories and their ability



to generate incomes. Its implementation is expected through the market survey and AFP Business plan which its consultancy will be conducted by BGR.

4.7 Summary on the status of AFP as of March 2024

With reference to “**Error! Reference source not found.**”, the installation of sample preparation laboratories as well as the analytical laboratory was successful.

However, it is still unclear whether the installed analytical laboratory equipment is fit to the need of sample analysis as no single sample has been fully analysed by the laboratory installed at AMGC in Dar es Salaam. All the analytical results in the AFP database are from analyses carried out either in Europe or South Africa. The development of the relevant technical AFP processes has not been tested on the ground, particularly on the various mineral supply chain scenarios. This has rendered the application of the AFP technology limited to basic and simple mineral supply chains.

Regarding capacity building, the project was successful as the staff at sample preparation laboratories and the AMU team can operate without the technical support of BGR while multiple setbacks were experienced repeatedly at the analytical laboratory where training efforts got lost due to trained staff leaving the AMGC.

As the external analysis of AFP samples is no longer an alternative option for the high number of samples currently stored at the AFP analytical laboratory, it was suggested that these will be analysed on request as a new round of trainings is underway for the staff of the Geological Survey of Tanzania, Tanzania Mining Commission and the AMGC.

The current AFP project phase has been extended for 2 years and will end in December 2024 and no further support will be provided afterwards.

Following a high-level ICGLR-BMZ virtual meeting held on 12 December 2022, a technical workshop involving BGR, GIZ, ICGLR, AMGC and representatives from the implementing Member States was held in Bujumbura from 31st January to 2nd February 2023 to identify measures that would enable the ICGLR apply and manage the AFP technology sustainably.

The technical workshop **concluded that the bottleneck of the AFP project implementation process was at the AFP regional laboratory which has negatively affected sensitization of Member States and the private sector on the use of the AFP as a complementary tool to enhance the integrity of the 3T mineral supply chain** and formulated the recommendations to the high-level meeting held on 08 March 2023.

This high-level workshop between BMZ and ICGLR as well as implementing Member States adopted most of the recommendations presented, among this **to agree on a costed workplan (2023 - 2024) with specific milestones.**



An operational planning workshop was held from 24th to 25th May 2023 in Dar es Salaam, United Republic of Tanzania to implement the above-mentioned recommendation of identifying key activities along with their allocated budget to be implemented in the period of 2023 – 2024 in preparation for a smooth handover of the whole AFP infrastructure to ICGLR.

The workshop was attended by the delegates from the Geological Survey of Tanzania, Geological Survey of the Democratic Republic of Congo, National Mineral Laboratory of the Burundi Mining Authority, the Directorate of the Geological Survey and Mines of the Republic of Uganda, the African Minerals and Geosciences Centre (AMGC), BGR, GIZ and the ICGLR Secretariat.

The workshop agreed on the workplan with key activities, responsibility, and timeline. Based on the budget allocation presented by the BGR project manager, the workshop developed a costed workplan according to the agreed upon activities aiming at ensuring a smooth handover of the AFP project to ICGLR.

Since then, there has been delays and changes in the implementation of activities due to back-and-forth discussions about the agreed activities. Hence, a high-level meeting was held in Bujumbura on 26th February 2024 between ICGLR, BMZ, GIZ, BGR, AMGC and representatives from implementing Member States to assess the status of implementation of the AFP project costed workplan in preparation for the handover of its infrastructure to the ICGLR.

During this high-level meeting, ICGLR underscored the importance of clearly defining the remaining timeline for the project activities, identifying the activities that can be implemented within the agreed timeframe and determining the roles and responsibilities of each party.

The meeting agreed to take the workplan as a basis to kickstart the activities that must be implemented prior to the handover of the AFP project to ICGLR; recommended to BGR and ICGLR to review and finalize the workplan, considering the recommendations and reservations expressed by the ICGLR Member States. ICGLR and BGR further agreed to provide a written response to the reservations expressed by the ICGLR Member States³ by the 2nd week of May 2024.

³ Individual Member States that attended the meeting made the following reservations:

- The representative of the Republic of Burundi expressed her reservation to the workplan, considering the limited time and slow progress in implementation thus far.
- The representative of the Republic of Uganda expressed his reservation to the workplan, requesting ICGLR and BGR to support the set-up of a sample preparation laboratory for Uganda.
- The representative of the Democratic Republic of Congo expressed his reservation to the workplan, requesting the signature of a Memorandum of Understanding between the DRC, ICGLR and BGR.



5. OUTLOOK: UPCOMING HAND-OVER

5.1 Items to be handed over.

All tangible assets (devices, appliances, items, installations, consumables, vehicles) purchased during the lifetime of the project with project funds as well as all related data, documentation and transcripts of records will be handed over to ICGLR, AMGC or national institutions if not already done. This comprises all moveable appliances, installations and furniture in the sample preparation laboratories and the analytical laboratory, office supplies of AMU at ICGLR Headquarters, BGR office supplies at AMGC and RMB and other locations that contain items purchased with BGR project funds for the AFP project.

5.2 BGR Options to proceed with AFP implementation.

On the background of the finalised AFP development and established setup of AFP entities, there are several possibilities how AFP could be managed by ICGLR after takeover from BGR, each with varying financial and operational impact.

From an objective view, **the analytical work should be able to be performed by any laboratory which possesses the relevant equipment.** On this background, the core of AFP is not the analytical work in the laboratory in a strict sense but the knowledge about the statistical evaluation of AFP and the access to the AFP database, both present at ICGLR. Therefore, every option between keeping the *status quo* of the AFP setup costing around €470.000 per year (table 8: option 1) to the minimum of 50.000 -100.000 USD/year (being the equivalent of the salaries +administration for keeping only 1-2 ICGLR staff trained on AFP; option 3) is conceivable to keep the AFP applicable.

Table 8: Overview of possible options to proceed with AFP; note that option 2 is one possible option between option 1 and option 3 which are at the extreme ends of the spectra of options

	Option 1: status quo	option 2: LAICPMS analysis by external laboratory	Option 3: AMU only
Costs	470.000 €/year	370.000 €/year	100.000 €/year
Implications concerning external laboratories/ service providers	all steps can be performed "in-house"	in case of AFP requests, AFP samples would have to be analysed after SEM analysis by an external laboratory	in case of AFP requests, all steps of AFP besides statistical data evaluation and data management would have to be performed by external service providers/ laboratories



Options between these extreme possibilities include e.g. the option to use furthermore only the SEM at the analytical laboratory that would save costs for depreciation, maintenance, and consumables for both the laser ablation system and the mass spectrometer culminating in a cost reduction of about 100.000 EUR annually (option 2). **Should there be any AFP requests, the LA-ICPMS analysis would then need to be performed externally for an estimated 1000 USD/sample.** According to these numbers, this option is preferable to the status quo unless there are more than 100 AFP analyses per year paid for by external actors/clients (reminder: until now a large number of samples submitted to the BGR project management have not been analysed for a number of years. This option is the recommendation by BGR.

5.3. ICGLR proposal on the implementation of AFP

In reference to the options proposed by BGR, the ICGLR Secretariat is of the view that the core of AFP includes the analytical work in the laboratory complemented by the knowledge about the statistical evaluation of AFP and the access to the AFP database. Keeping the current design of the AFP setup seems to come with a number of additional benefits which include, a high-tech laboratory capable of providing a combination of unique AFP and non-AFP analytical services in the region.

During the high-level meeting between ICGLR, BMZ, BGR, GIZ, AMGC and representatives from implementing countries on 26th February 2024 in Bujumbura, Burundi, it was agreed that BGR fixes the ICP-MS machine and continue the training sessions on the AFP analytical laboratory, which need to be extended to other relevant institutions of other Member States, i.e., OBM-Burundi, SGN-C DRC and DGSM-Uganda.

In view of the above and given that the ICP-MS can offer a wide range of non-AFP analytical services, the AFP analytical laboratory will need to be hosted and operated by an institution from Tanzania where it is currently hosted by AMGC. The Geological Survey of Tanzania (GST) and the Tanzania Mining Commission (TMC) would be assigned the task to decide which institution with some degree of administrative and financial autonomy would host the AFP analytical laboratory in Dar es Salaam. A Memorandum of Understanding between ICGLR, GST-TMC/Ministry of Minerals and the host institution would be required to define the parties' roles and responsibilities as well as commitments and clarify management and sustainability issues of the laboratory.

5.4 Potential use of analytical AFP lab for AFP-unrelated analyses

Besides the benefits related to AFP application into the Regional Certification Mechanism upon request by different actors of the mineral supply chains, the AFP analytical laboratory can be used to provide other non-AFP analytical services.



TESCAN TIMA, an advanced automated mineralogy system, can provide quantitative mineralogical and textural data, false-colour mineral maps, and statistical insights to industries and research. Its applications include:

1. **Mineral Exploration and Mining:** TIMA identifies mineral compositions and textures in ore samples to guide exploration. It optimizes heavy mineral analysis, aiding efficient extraction from complex geological formations, leading to substantial cost savings and improved profitability.
2. **Mineral Processing:** TIMA's analysis of ores, concentrates, and tailings during processing offers actionable data to enhance efficiency. Characterizing particle size and mineral liberation analysis improves processing steps, reducing costs and increasing yields of target minerals, resulting in significant cost savings and enhanced productivity for mining companies.
3. **Oil and Gas Industry:** TIMA's detailed analysis of rock samples from oil and gas reservoirs provides essential insights into mineral composition, pore structure, and grain size. This information is vital for reservoir characterization, guiding exploration strategies, and predicting hydrocarbon behaviour within geological formations.
4. **Environmental Science:** TIMA facilitates comprehensive environmental studies, analysing soil composition, contamination levels, and geological formations. It aids environmental monitoring and remediation efforts by identifying minerals in samples. By tracking mineralogical changes, especially in industrial or mining areas, TIMA aids in contaminant identification, evaluates remediation success, and ensures effective conservation strategies.

Based on the Cooperation Agreement between ICGLR and AMGC, a series of consultation meetings were held since February 2022 on the sustainability of the AFP analytical laboratory. This will rely on the commercialization of its activities to public and private sector across ICGLR and AMGC Member States and the continent.

Potential use of AFP analytical laboratory for AFP-unrelated analyses (water analysis, soil and rock samples and analysis of single grains) and related service incomes were jointly evaluated by BGR, AMGC and ICGLR in October 2022. It is important to keep in mind that in addition to the technical equipment, appropriate expertise in the field of application is required.

The above services have substantial demand from the rising industrial, service and research programs from the region and the world at large. Already demand for the above services has been received from various customers but due to lack of a strategy/plan and standard operating procedures, the above demand for services has not yet gotten due attention.



5.5 Potential use of sample preparation laboratories

The sample preparation laboratories are equipped with the necessary tools and skilled staff to create polished and thin sections. These services can be provided also to mining companies, universities, and geological surveys, facilitating geoscientific research. Depending on already existing infrastructure in the host-countries, the services could contribute significantly to geoscientific work and research, because sections serve as fundamental elements for geoscientists.

5.6 Hand-over process and timeline

Upon notification of German Federal Ministry for Economic Cooperation and Development (BMZ) in December 2022 on its intention to phase out the AFP project by December 2024, the ICGLR embarked on a series of consultation meetings with BMZ, implementing Member States, AMGC, BGR and GIZ jointly convened with BMZ both at technical and leadership levels to prepare for the handover process.

At difference occasions, it was agreed upon that the handover should take place in an amicable spirit of respect that honours the cooperation that lasted more than a decade.

These consultations came up with a costed workplan developed in May 2023 to be implemented in preparation for the handover. Unfortunately, the recent high-level meeting held in Bujumbura in February 2024 noted that the workplan was not implemented due to unilateral delays and changes in the workplan by BGR. While the meeting agreed to take the workplan presented by BGR as a basis to kickstart the activities that must be implemented prior to the handover of the AFP project, ICGLR and BGR agreed to review and finalize the workplan, considering the recommendations and reservations expressed by the ICGLR Member States. Furthermore, ICGLR underscored the importance of clearly defining the remaining timeline for the project activities, identifying the activities that can be implemented within the agreed timeframe and determining the roles and responsibilities of each party.



5.7 List of BGR scientific publications on AFP Project

Melcher, F.; Sitnikova, M.; Graupner, T.; Martin, N.; Oberthür, T.; Henjes-Kunst, F.; Gäbler, E.; Gerdes, A.; Brätz, H.; Davis, D.; et al. Fingerprinting of conflict minerals: Columbite-tantalite ("coltan") ores. SGA News 2008, 23, 1-14.

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Gäbler, H.-E.; Rehder, S.; Bahr, A.; Melcher, F.; Goldmann, S. Cassiterite fingerprinting by LA-ICP-MS. J. Anal. At. Spectrom. 2013, 28, 1247-1255.

Gäbler, H.-E.; Schink, W.; Goldmann, S.; Bahr, A.; Gawronski, T. Analytical fingerprint of wolframite ore concentrates. J. Forensic Sci. 2017, 62, 881-888.

Martyna, A.; Gäbler, H.-E.; Bahr, A.; Zadora, G. Geochemical wolframite fingerprinting – the likelihood ratio approach for laser ablation ICP-MS data. Anal. Bioanal. Chem. 2018, 410, 3073-3091.

Gäbler, E., Schink, W., Gawronski, T., 2020. Data evaluation for cassiterite and coltan fingerprinting. Minerals, 10, 926

6. DETAILED ANNUAL COSTS OF THE AFP ANALYTICAL LABORATORY

Equipment costs

Device	Procurement	Currency	USD	EUR
TIMA	579,724	USD	579,724	515,954
NWR Laser	110,000	EUR	118,038	110,000
Mass Spectrometer	235,000	EUR	252,171	235,000
Preparation Lab	59,600	EUR	63,955	59,600
		Total	1,013,888	920,554
		10% depreciation	101,389	92,055



Service contracts

Device	Service Cost (Annual)	Currency	USD	EUR
Mass Spectrometer	28,000	USD	28,000	24,920
TIMA	52,000	EUR	58,427	52,000
NWR Laser	18,000	EUR	20,225	18,000
Generator	1,086	USD	1,086	967
AC	3,422,000	TZS	1,506	1,335
PV System	8,400,000	TZS	3,696	3,276
Total			112,939	100,497

Consumables

Gases analytical			USD	EUR
Argon	Estimate under assumption: 250 working days, 8 AFP measurements per every 5 days, 15% capacity of laboratory		7,060.34	6,284
Helium			2,264.40	2,015
Nitrogen			108.62	97
Cylinder rent			1,655.17	1,473
Consumables, various (AFP)			500.00	445
		Total	11,589	10,314

Operating costs

Gases analytical			USD	EUR
1000 liter diesel for generator	3,400,000	TZS	1,360	1,210.40
staff (2 chemists + 1 driver)			36,000	32,040.00
utilities (water, electricity, cleaning)			2,580	2,296.20
compliance (OSHA, ...)			500	445.00
Miscellaneous			3,000	2,670.00
car + fuel			6,200	5,518.00
clearing fees			5,000	4,450.00
total			54,640	48,629.60

TOTAL 280,557 251,496



The basis of these data is purchasing prices of equipment in 2016/17 and a table compiled during a joint meeting of ICGLR, AMGC and BGR in October 2022. Current prices for equipment and services must be estimated higher.

7. ANNEX

- Reports of the Technical and High-Level Meetings held between January 2023 and February 2024
- Costed AFP Workplan to be implemented in preparation for the handover