Proceedings Kenya Geothermal Congress 2024.
Nairobi, Kenya, 16 – 18, July, 2024.

Spatiotemporal dynamics of geothermal parameters on the Cameroon volcanic line: characterization and evolutionary trends.

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Keywords:

Cameroon Volcanic Line, Geothermal, Dynamic, Evolutionary trends.

ABSTRACT

Cameroon possesses all the necessary elements for the establishment of a thriving geothermal industry, including an active volcanic line, regular eruptions of Mount Cameroon, and the presence of thermal springs. These factors make it an ideal location for harnessing clean and renewable energy. Surprisingly, despite these favorable conditions, no comprehensive studies have been conducted to fully explore the potential of geothermal energy in Cameroon. The only existing research dates back to Le Maréchal's work in 1976, which documented a total of 130 thermal springs concentrated along the corridor of the Cameroon Volcanic Line. The main objective of this study is to examine the challenges surrounding geothermal exploration in Cameroon, specifically focusing on the evolutionary trends of geothermal parameters of Cameroon volcanic line development and the level of knowledge among academics regarding geothermal energy. Initially, a comprehensive analysis of the existing literature on the energy sector in Cameroon was undertaken. The geothermal exploration in Cameroon, as identified in the literature, includes inadequate policies, limited financial resources, lack of trained personnel, constrained environments, and a lack of awareness among stakeholders, investors, and academics. The literature also emphasizes the insufficient knowledge and awareness of academics regarding geothermal energy. Cameroon has yet to fully tap into the potential of geothermal energy, making it an area ripe for exploration and development. To begin this process, it is suggested that a surface exploration be conducted in Cameroon, utilizing a combination of geological, geochemical, and geophysical methods. By employing these techniques, valuable insights can be gained into the geothermal resources available in the country. Obtaining data on the location, area, extent, volume, geometry, and boundary conditions of potential geothermal resources, as well as information on resource permeability, density, heat capacity, and conductivity, is anticipated. Ultimately, there is a need to enhance knowledge and understanding, geothermal exploration.

I. INTRODUCTION

Cameroon, situated in the Gulf of Guinea between latitude 2 and 13 degrees north and longitude 9 and 16 degrees east, is a Central African nation. With an area of 475,650 km2 , it boasts a triangular shape that extends approximately 1200 km south to Lake Chad, while its base spans about 800 km from west to east. Along the Atlantic Ocean, Cameroon has a southwestern maritime border of 420 km. It shares borders with Nigeria to the west, Congo, Gabon, and Equatorial Guinea to the south, the Central African Republic to the east, and Chad to the northeast 3. The population of Cameroon stands at 27,994,885 inhabitants (CDP, 2022). Urban areas house approximately 54.4% of the population, while rural areas accommodate the remaining 45.6%. With a population that continues to grow, Cameroon holds the distinction of being the most populous country in Central Africa. The population growth rate stands at 2.59% (2022), and the economic (GDP) growth rate is 5.9% (2022). Agriculture employs over 60% of the active population in Cameroon, contributing to 42% of the GDP, while mining and industry account for 22% [16]. Cameroon possesses a vast array of energy resources, including oil, natural gas, forestry, hydropower, wind, solar, biomass, and geothermal. However, the utilization of these resources, particularly renewable sources, has been insufficiently developed ([11]). Access to energy plays a crucial role in a country's economic and social progress. The level and intensity of commercial energy consumption serve as significant indicators of socio-economic development. As income levels rise and urbanization accelerates, the demand for household energy also increases. Unfortunately, the energy sector in Cameroon has struggled to meet the electricity needs of the country. Despite the abundance of energy resources, many remain untapped. Hydroelectric power currently accounts for approximately 73% of electricity generation, while combustible fossil fuels (oil and natural gas) and biomass contribute 26% and 1% respectively. Consequently, it is imperative to explore new solutions that enhance energy access and ensure its sustainability. The potential for a thriving geothermal industry that offers sustainable and clean energy is heightened in Cameroon due to the presence of an active volcanic line, which is further highlighted by thermal springs and frequent eruptions of Mount Cameroon (last observed in 1999 and 2000). Despite the identification of 130 thermal springs concentrated in the corridor of the Cameroon Volcanic Line, with temperatures reaching as high as 74°C in Woulndé, no comprehensive assessments have been conducted to determine their complete capacity and possibilities. The focus of this research is to examine the matter of geothermal exploration in Cameroon, with a particular emphasis on the current patterns of progress in the field of geothermal energy. The study aims to determine the existing knowledge and understanding of the energy sector, including renewable energy, as well as the level of awareness regarding geothermal energy in Cameroon.

II. ENERGY SECTOR IN CAMEROON

1. Solar energy

Cameroon has good potential for solar energy exploitation. In the most suitable parts, the average solar irradiance is estimated at 5.8 kWh/day/m2 (in the Northern parts of the country), while the rest of the country commonly sees 4.9 kWh/day/m2 (UNIDO, 2016b). This potential, however, is weakly valorized despite the availability of ideal conditions throughout the country. Solar power is currently used in distributed generation systems, particularly for powering. the cellular telecommunications network. However, only approximately 50 PV (Photovoltaic) installations currently exist [13] . Other recent applications include: solar street lighting; solar security and surveillance cameras for both streets and public offices; solar phone charging for small businesses and remote applications; solar home systems for both remote and some city applications; solar-powered deep freezers and air conditioning systems [16].

2. *Wind energy*

Most of the country has insufficient wind speed for power production with an average of 2-4 m/s at the height of 100 meters. However, the Northern and Littoral regions of Cameroon have substantial potential for wind energy with wind speeds averaging 5-7 m/s [6]. The wind energy potential of Cameroon is not as vast as solar and very low consideration has been devoted to it so far. The potential of wind energy for small scale applications (water pumping systems, water farms for livestock and small irrigation schemes) for rural households in the far north region of Cameroon has been assessed by [14].

3. Biomass energy

Cameroon has the third largest biomass potential in sub-Saharan Africa, with 25 million hectares of forest covering three-quarters of its territory [13] However, the unsustainable use of this resource has led to significant deforestation throughout the country, with an annual clearance rate of 200,000 ha/yr. and regeneration of only 3,000 ha/yr. Primary uses for biomass in the country include heating and light for the majority of the rural population [9].

4. Geothermal energy

Potential for geothermal energy exists in Cameroon. However, the exact capacity is unknown since no investigation has been yet carried out to estimate this potential despite some recent academic/research works of [12]. Nevertheless, hot springs are found in extensive areas: Ngaoundéré area, Mt Cameroon area and Manengouba area with Lake Moundou [10]. Renewable Energy Policy / Existing Policies and Legal Framework Cameroon has set the goal of being an emerging country within the next 30 years, and announced 'Cameroon Vision 2035', which proposes a strategy to accomplish this goal. 'VISION 2035' can be considered as a reference framework that guides policy, national strategy, and development plans and cooperation for entire sectors and regions in Cameroon [6]. The energy sector is one of the important sectors that will assist the country to achieve 'VISION 2035'. In Cameroon, a renewable energy policy is being prepared, with policy goals to increase the share of renewable in power and heat generation, and to involve private capital in the delivery of energy [15]. In order to attract private investors into the energy and renewable energy sectors in Cameroon, special mechanisms have been introduced: equipment manufacturers benefit from import tax reduction and special fiscal measures, and the Rural Energy Fund subsidizes inv[16]. The government's policy seeks to get the country out of under-development, through the implementation of the long-term Energy Sector Development Plan (PDSE 2035) and the Poverty Reduction Strategy Paper (PRSP). Development of the energy sector is seen as a factor for attracting investment and strengthening growth. Moreover, Cameroon's development objectives under the Vision 2035 envisage significant investments in the energy sector, with the inclusion of renewable. The policy goals of the government are to ensure energy independence through increased production and delivery of electricity, of oil and gas (petroleum resources) and to ensure their contribution to economic development. However, prior to that, there are some existing policies that highlight renewable energy in Cameroon. The renewable energy sector has been in consideration since 1996 as according to article 24 of law N° 96/12 of 5th August 1996, relating to Environmental management. According to this article, the competent ministry in collaboration with the ministry in charge of environment and the private sector are in charge of producing renewable energy so as to protect the atmosphere. The level of intervention of each party is not clearly stated in this legal document. The Law N°2011/022 of 14th December 2011 governing the electricity sector in Cameroon attempts to organize the renewable energy sector in Cameroon [10] and creates the Department of Renewable Energy. Article 59(2) imposes the use of renewable energy in the implementation of the decentralized rural electrification program so as to encourage environmental protection. This law also imposes the obligations for the energy operator to buy all renewable energies produced but the price is not fixed in this document.

III. STATUS OF GEOTHERMAL ENERGY IN CAMEROON

Geological Setting: The Cameroon Volcanic Line (CVL) The Cameroon Volcanic Line is a linear magmatic megastructure 100 km wide oriented N30°E, that extends more than 1500 km from Pagalu Island in the Gulf of Guinea to Lake Chad[3], [2] , [7] In the ocean sector, it consists of four volcanic islands (Pagalu, Sao Tome, Principe, and Bioko) and two seamounts, all located in the Gulf of Guinea 1. The continental area consists of a series of volcanoes in Cameroonian territory. Monogenic volcanoes include Noun Plain (Wandji, 1995), Tombel, and Tikar. Polygenic or stratovolcanoes include Mt Cameroon [2], Mt Manengouba, Mts Bamboutos [5], Mt Bamenda, and Mt Oku. In the continental area of CVL, more than sixty anorogenic complexes have been studied, including Mount Kupe, Nkogam, the massif Mayo Darle, Nlonako, and Nda Ali. Initial activity concerning these anorogenic complexes is dated at 82 Ma (Jurassic to Cretaceous) for plutonism and 51 Ma for basaltic volcanism.

1. The Impact of the 1982 Eruption of Mount Cameroon

The Aftermath of the 1982 Eruption of Mount Cameroon: An Analysis of Geological, Environmental, and Societal Effects the aftermath of the 1982 eruption of Mount Cameroon was a period marked by significant geological, environmental, and societal challenges. In the seven decades leading up to this event, lava flows from Mount Cameroon had already threatened or indirectly impacted nearby towns on five separate occasions [4]. This recurrent threat underscored the importance of close monitoring of the volcano, leading to the installation of seismometers in the 1980s designed to track volcanic activity and potentially provide early warnings of future eruptions. The eruption in 1982 served as a critical point of analysis for understanding the broader implications of Mount Cameroon's activity. Researchers focused on dissecting the likely geological changes that occurred as a result of the eruption, such as alterations in the landscape and new lava formations. They also examined the environmental consequences, including the impact on local ecosystems and air quality, as well as the societal effects, which encompassed the displacement of communities and the disruption to local economies. This comprehensive analysis aimed to provide insights into the multifaceted aftermath of volcanic eruptions, highlighting the interconnectedness of geological phenomena with environmental health and human societies.

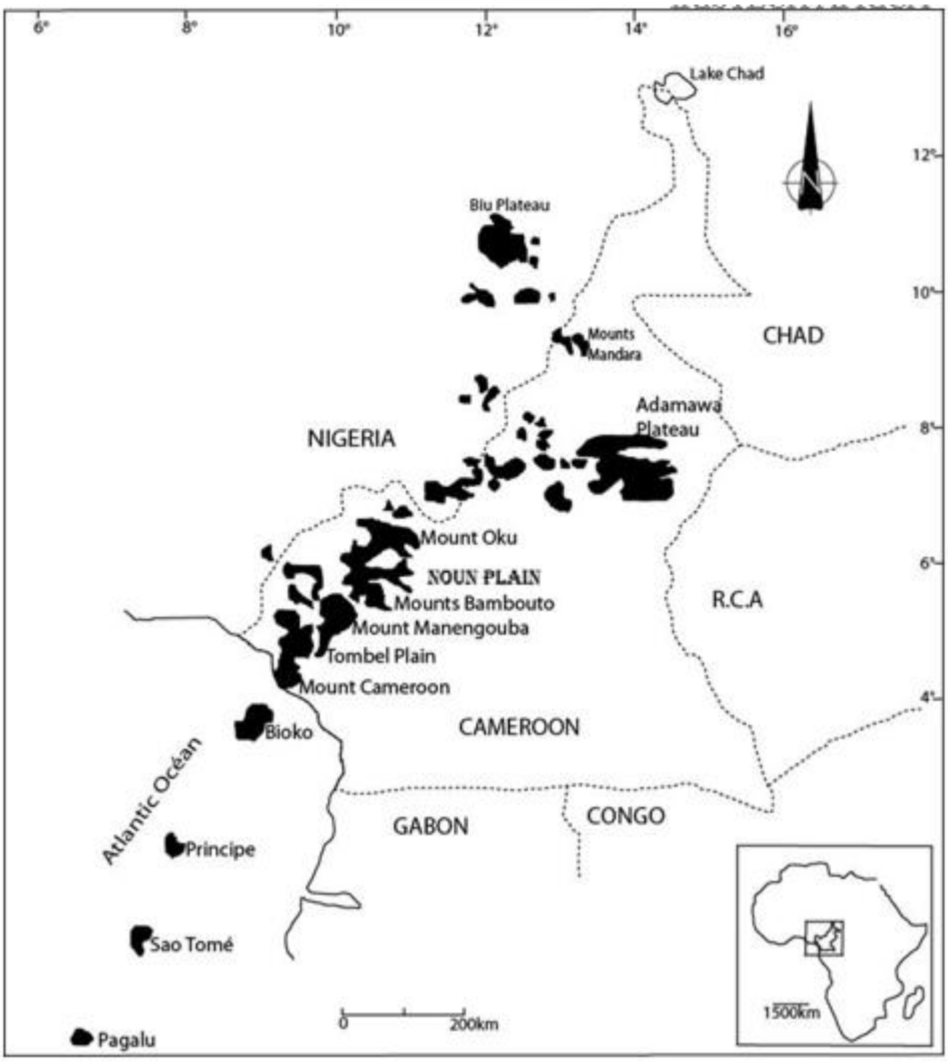


Figure 1 Cameroon Volcanic Line (simplified from Marzoli et al. ,2000)

2. Eruption of Lake Monoun 1984

The Causes, Impacts, and Lessons Learned from the 1984 Lake Monoun Eruption: A Comprehensive Study The tragic event at Lake Monoun in 1984, which led to the loss of 37 lives and numerous animals, initially baffled authorities and led to speculations including domestic terrorism as a potential cause [19]. Witnesses described hearing unsettling rumbling sounds followed by the emergence of an eerie white cloud from the lake, which quickly dissipated, adding to the mystery and urgency for explanations. Subsequent investigations and studies revealed that such catastrophic events, known as limnic eruptions, could be triggered by changes in temperature or pressure, resulting in the explosive release of dissolved carbon dioxide accumulated in the lake's depths. This understanding underscored the importance of comprehensive research to unravel the complexities behind such natural disasters, emphasizing the need for a thorough examination of the causes, impacts, and preventive measures to avert future occurrences. of iron oxides stirred up during the degassing process initiated in the aftermath. This degassing process was a direct response to the disaster, aimed at mitigating future risks by safely releasing trapped carbon dioxide from the bottom of the lake. The event underscored the urgent need for effective natural disaster management and mitigation strategies, paving the way for increased research and preventive measures to avoid similar tragedies in the future.

IV. GEOTHERMAL HOT SPRINGS

In Cameroon, a spring is characterized as thermal when its temperature is above the mean temperature of 23°C (Le Maréchal, 1976)[1]. One hundred and thirty thermal springs were recorded by Le Maréchal (1976). They are concentrated in the corridor of the CVL .

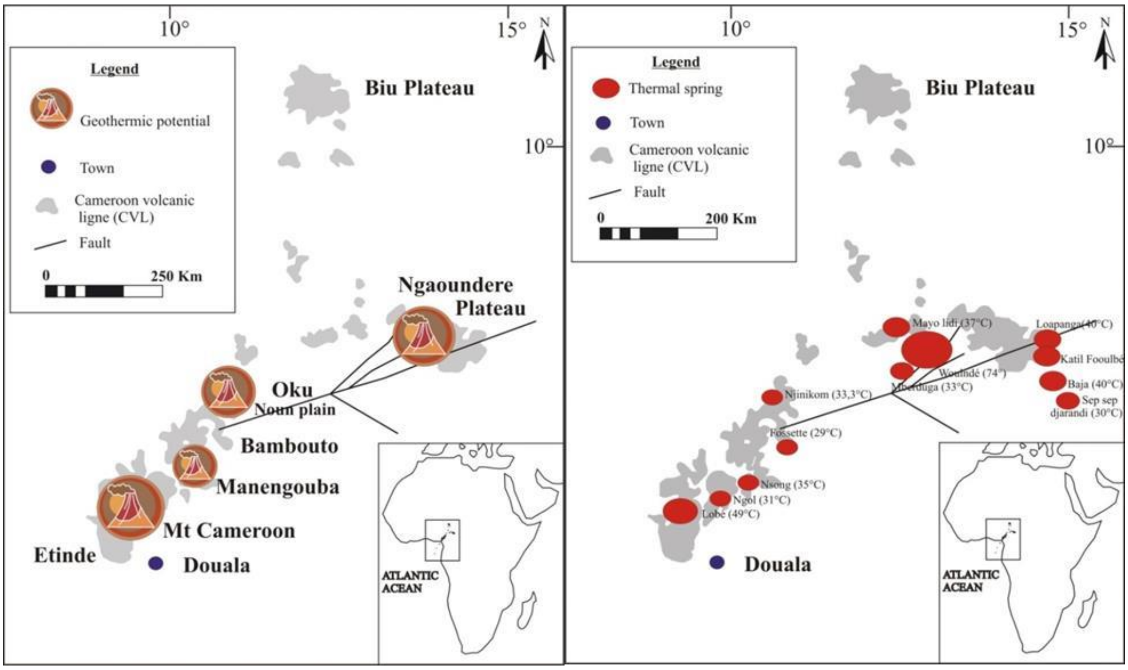


Figure 2 Présentation of some major thermal springs of the Cameroon Volcanic Line (Tetchou and Tchouankoue, 2014).

However, the current data available includes a detailed investigation of only 40% of the Cameroonian territory. The hottest spring (Woulndé, 74°C) is located in the Adamaoua region of Cameroon, at the intersection between the CVL and the Adamawa shear zone, a transcontinental lineament that extends from Cameroon to the Red Sea. Just behind the Woulndé spring is the Lobe spring with a temperature of 49°C, located at the foot of Mount Cameroon. The location of these hot springs is distributed along the CVL. The largest number of springs is located in the region of Adamawa .

V. DISCUSSION: BARRIERS TO GEOTHERMAL EXPLORATION

According to the literature review and the investigation, barriers to the exploration of geothermal energy are:

• Poor energetic policy: Cameroon, unlike many other African countries such as Nigeria, has no clear energy policy and hence no clear guidelines regarding renewable. However, most of the laws enacted in the Cameroonian parliament have aspects of renewable but mostly hydropower is usually addressed [13]. The regulatory framework of renewable energy is almost void despite some measures previewed by the 2011 law on electricity; the absence of application texts does not permit the active operation of renewable energy in Cameroon. Furthermore, the 2035 Energy Sector

Development Plan gives future projections on renewable energies but does not consider other sources like geothermal, solar, wind, and biogas [16].

• Incentives: There is an absence of fiscal incentives and subsidies for renewable, although the government of Cameroon has established a strategy to modernize the electricity sector with several measures to facilitate the deployment of renewable [8]. The present prevailing framework in Cameroon does not encourage the widespread use of clean energy technologies given the high taxes and custom duties in the country [16]. Also, renewable energy promoters are not exempted from taxes and this may have a political impact on both private and public sectors. There is a lack of legislative texts that encourages the local manufacturing of renewable energy equipment.

• Institutional environment: There is a lack of strong, dedicated institutions, lack of clear responsibilities, complicated, slow or non-transparent permitting procedures. Inadequate investment regulations, standards, and quality control mechanisms do not encourage investments. The legal framework of Cameroon is not clearly defined and also there are no existing texts on the renewable energy sector in Cameroon. Meanwhile, the Law No 2011/022 of 14 December 2011 governing the electricity sector of Cameroon gives a little attribution of renewable energy but with a lot of insufficiency. • Techno-economic barriers: There is inadequate technological capacity and Cameroon being a developing country has a very low capital income thereby making it very difficult to afford adequate technology to develop the renewable energy sector.

• Financial barriers: There have been inadequate funding opportunities in the sector of renewable energy in Cameroon.

• Infrastructure barriers: Absence of infrastructures such as an executing body to manage renewable energy government in order to integrate or absorb renewable energy.

• Inadequate knowledge about geothermal energy and unskilled personnel: Cameroon equally faces inadequate sensitization on the environmental benefits of renewable energy as well as the inadequate number of trained renewable energy experts in the country. In fact, academics are among the main actors for the development of such a new domain and unfortunately, their knowledge about geothermal seems insufficient.

• Low priority given to renewable development of geothermal energy: The Cameroonian government is the main actor for the development of the energy sector, but not much is done with regard to geothermal energy.

VI. CONCLUSION AND RECOMMENDATIONS

Geothermal exploration aimed at the identification and characterization of potential geothermal faces many challenges and obstacles in Cameroon despite the presence of volcanic activity and geothermal manifestations. Among the main obstacles identified, there are inadequate policy, regulatory and institutional framework, funding constraints, technology constraints, inadequate skilled manpower and training institutions, and unawareness of academics, government, and investors. Despite these obstacles, geological, geophysical, and geochemical research must nevertheless be carried out; the main parameters for geothermal resource exploration being the identification of the heat source, reservoir rock, impervious cap rock, and recharge of the system. In order to achieve good geothermal exploration in Cameroon, the following geothermal activities have to be carried out: Geological survey, which consists mainly in geological mapping of potential geothermal areas to investigate the tectonic, volcanic, and geology of the area. The aim of the structural geological mapping will be to expound on the structural setting of fields, to identify parameters that support the existence of a geothermal system namely; heat source, permeability, and recharge mechanism; Geochemical surveys to predict subsurface temperatures, to obtain information on the origin of the geothermal fluid and to understand subsurface flow directions [5].

The results obtained after measurements of surface temperature, water, and gas flow as well as water and gas analyses of the hot springs could also be used to assess the geothermal potential;

And regional and semi-detailed geophysical studies carried out in geothermal prospect areas with the aim of investigating the deep structures and delineating possible geothermal reservoir and heat source. Many methods such as electrical, magnetotelluric, and gravimetric studies, using MT and TEM, DC resistivity methods, gravity, and magnetics have to be conducted to study the subsurface structure. Geothermal power is a reliable, low-cost, environmentally friendly, alternative energy supply, renewable energy source, suitable for electricity generation. Economically, Cameroon depends a lot on agriculture, fishing, and breeding, so the direct applications of geothermal resources could boost these sectors. Development of alternative energies from renewable sources such as geothermal will be a key part of Cameroon's energy diversity.

Recommendations for the Coming Years:

• Detailed structural geology field mapping accompanied by geochemical and geophysics surveys along the Cameroon Volcanic Line. If geophysical, geochemical, and detailed structural mapping results prove positive, the potential areas should be investigated further to delineate the reservoir and understand its size and volume.

• Introduction and application of new policies that will create a highly attractive climate for foreign investment, trade liberalization, financial sector reform, privatization, and special tax incentives.

• Creation of a national agency that handles the promotion of renewable energy

• Inclusion of renewable energy studies in the Cameroon curricula at all educational levels.

• Massive sensitization in the area of renewable energy in Cameroon.

• Training of Cameroonian experts in acquiring, analyzing, and interpreting exploration data.

• Establishment of fruitful collaborations with institutions specialized in geothermal energy around the world.

• Dissemination of information about the possibilities of geothermal energy use in Cameroon among decision-makers and search for funds.

• Ensure continuous monitoring of volcanic lake areas such as Nyos and Monoun to detect early warning signs of a natural disaster and gather the necessary information for a better understanding of the Cameroon Volcanic Line, as it appears that the degassing pipes currently on site are obstructed.

REFERENCES

[1] A. l. Marechal. “Geologie et geochimie des sources thermominerales du Cameroun”. In: Trav. Doc. ORSTOM 59 (1976), page 176.

[2] B. Déruelle, C. Moreau, and N. NSIFA. “SUR LA RECENTE ERUPTION DU MONT CAMEROUN, 16 OCTOBRE-12 NOVEMBRE (1982)”. In: (1983).

[3] J. Fitton. “The Cameroon line, West Africa: a comparison between oceanic and continental alkaline volcanism”. In: Geological Society, London, Special Publications 30.1 (1987), pages 273–291.

[4] S. Arnorsson. “Geothermal exploration techniques”. In: Geothermics 29.1 (2000), pages 159–169.

[5] A. Marzoli, E. Piccirillo, P. Renne, G. Bellieni, M. Iacumin, J. Nyobe, and A. Tongwa. “The Cameroon Volcanic Line revisited: petrogenesis of continental basaltic magmas from lithospheric and asthenospheric mantle sources”. In: Journal of petrology 41.1 (2000), pages 87–109.

[6] R. Tchinda and E. Kaptouom. “Wind energy in Adamaoua and North Cameroon provinces”. In: Energy Conversion and Management 44 (2003), pages 845–857.

[7] B. Déruelle, I. Ngounouno, and D. Demaiffe. “The ‘Cameroon Hot Line’(CHL): a unique example of active alkaline intraplate structure in both oceanic and continental lithospheres”. In: Comptes Rendus. Géoscience 339.9 (2007), pages 589–600.

[8] T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein. Introduction to Algorithms. MIT press, 2009.

[9] B. N. Tansi. “An Assessment of Cameroon’s renewable energy resource potential and prospects for a sustainable economic development”. PhD thesis. BTU Cottbus-Senftenberg, 2010.

[10] Africa-EU Renewable Energy Cooperation Programme (RECP) Africa-EU Private Sector Cooperation: Matchmaking for win-win business opportunities in the renewables sector? Concept Note for a side event at the VIENNA ENERGY FORUM 2013, 28-30 May 2013. Concept Note. Vienna Energy Forum 2013. 2013.

[11] L. Ayompe and A. Duffy. “An assessment of the energy generation potential of photovoltaic systems in Cameroon using satellite-derived solar radiation datasets”. In: Sustainable Energy Technologies and Assessments 7 (2014), pages 257–264.

[12] J. D. Kana, N. Djongyang, D. Raıdandi, P. N. Nouck, R. Nouayou, T. C. Tabod, and O. Sanda. “Geophysical investigation of low enthalpy geothermal potential and ground water reservoirs in the Sudano-Sahelian region of Cameroon”. In: Journal of African Earth Sciences 110 (2015), pages 81–91.

[13] A. A. Mas’ud, A. V. Wirba, F. Muhammad-Sukki, I. A. Mas’ud, A. B. Munir, and N. M. Yunus. “An assessment of renewable energy readiness in Africa: Case study of Nigeria and Cameroon”. In: Renewable and Sustainable Energy Reviews 51 (2015), pages 775– 784.

[14] D. K. Kidmo, K. Deli, D. Raidandi, and S. D. Yamigno. “Wind energy for electricity generation in the far north region of Cameroon”. In: Energy Procedia 93 (2016), pages 66– 73.

[15] J. D. Kana, N. Djongyang, D. Raïdandi, and B. T. Ramadhan. “Appraisal of geothermal resources and use in Cameroon”. In: African Journal of Science, Technology, Innovation and Development 9 (2017), pages 661–667.

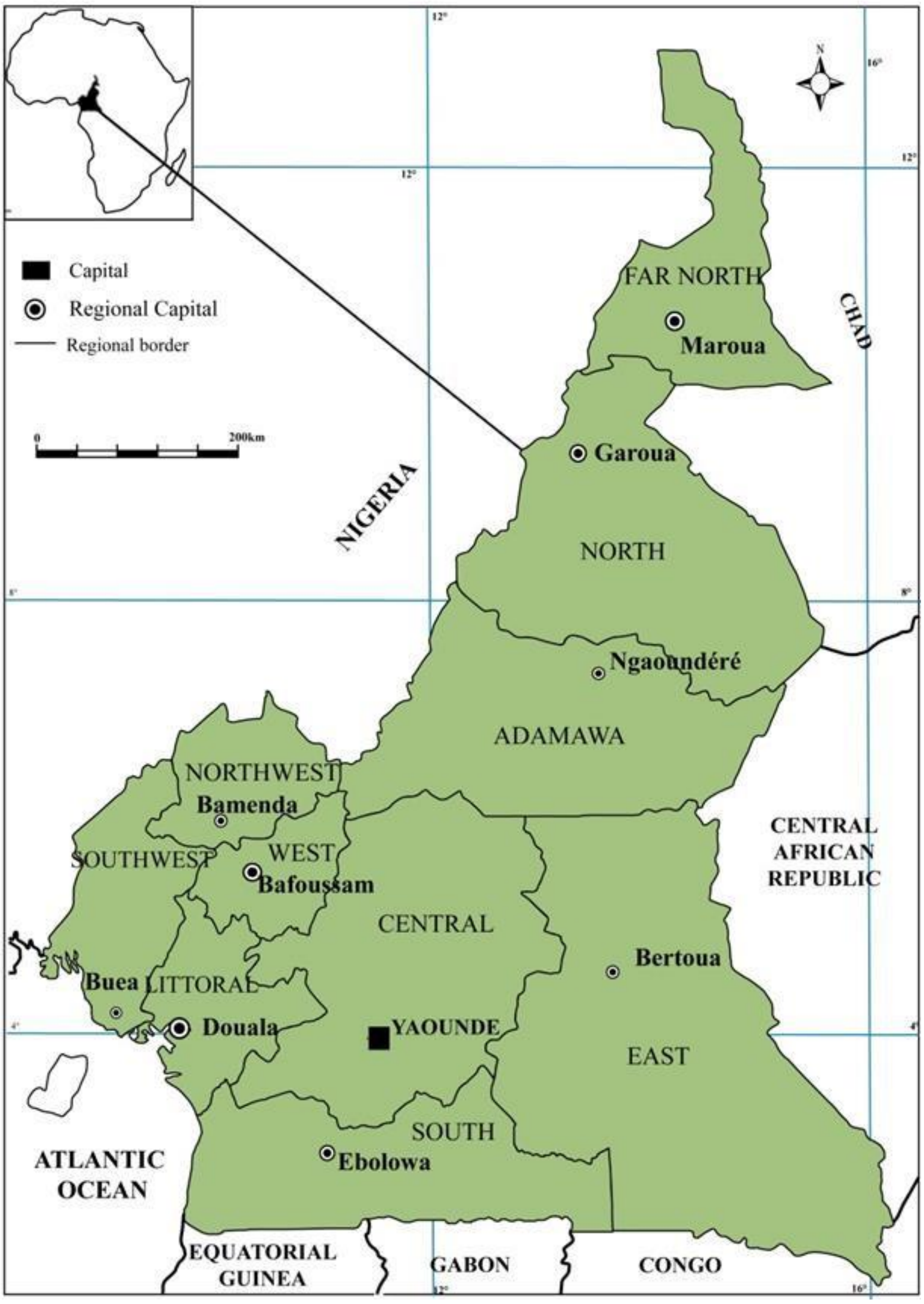
[16] E. Muh, S. Amara, and F. Tabet. “Sustainable energy policies in Cameroon: A holistic overview”. In: Renewable and Sustainable Energy Reviews 82 (2018), pages 3420–3429.

[17] G. T. D. Rouwet and A. Costa. MS Windows NT Cameroon’s Lake Nyos Gas Burst: 30 Years Later. https://eos.org/science-updates/cameroons-lake-nyo s-gas-burst-30-years-later. Accessed: 2016-06-12.

[18] J. R. SAYLO. MS Windows NT The Invisible Threat Beneath Cameroon’s Deadly Lake Nyos. https://www.atlasobscura.com/articles/lake-nyos-1986. Accessed: 2022-06-09.

[19] A. Taylor. MS Windows NT Killer Lakes: Why Limnic Eruptions May Be the World’s Rarest Natural Disasters. https://www.mentalfloss.com/posts/limnic eruptions-v. Accessed: 2023-08-23.

ANNEXE 1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SOUTH
Ebolowa
CENTRAL
AFRICAN
REPUBLIC
ATLANTIC
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EQUATORIAL
GUINEA
GABON
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ANNEXE 2

Region	District	Name	Coordinnates Long/Lat.	Temperatures (°c)
Adamawa	Ngaoundéré	Bajanga	14°00'35'' 7°17'10''	23.8
	Meiganga	Baja	18°06'10'' 7°08'55''	40.0
	Meiganga	Barkeje	14°45'40'' 7°00'50''	23.0
	Tignère	Bemlari	12°13'30'' 7°44'25''	25.0
	Tignère	Burlel1	12°18'55'' 7°37'15''	27.0
	Tibati	Damfili	13°00'00'' 6°96'00''	25.6
	Tignère	Deodeo	12°02'10'' 7°28'25''	28.5
	Tignère	Donkere	12°13'35'' 7°46'25''	26.4
	Meiganga	DzirKoya	14°40'25'' 6°56'00''	28.0
	Tignère	Falkoumre	12°35'30'' 7°19'35''	23.0
	Meiganga	Gbengubu	14°26'30'' 6°46'30''	23.0
	Ngaoundéré	Gogarma	14°15'30'' 7°18'25''	25.6
	Tignère	Guisire	12°24'25'' 7°25'10''	25.4
	Ngaoundéré	KatilFoulbe	13°56'00'' 7°06'00''	40.0
	Meiganga	Koulama	14°25'11'' 6°45'50''	26.0
	Ngaoundéré	Laobalewa 1	13°42'25'' 7°11'00''	23.4
	Ngaoundéré	Laofuru	13°35'25'' 7°12'10''	24.4
	Ngaoundéré	Laopanga	13°41'00'' 7°11'10''	40.0
	Tignère	Lasum	12°17'35'' 7°44'10''	28.8
	Meiganga	Mala0	14°02'20'' 6°46'40''	25.4
	Ngaoundéré	Matari	13°28'10'' 7°16'30''	23.0
	Tignère	MayoBaleo	12°16'00'' 7°41'25''	25.2
	Tignère	MayoLidi	12°06'55'' 7°23'05''	37.0
	Tignhe	Nalti	12°28'00'' 7°49'30''	24.5
	Banyo	Nialan	11°35'25'' 6°31'00''	23.4
	Tignhe	Patarlay	12°19'40'' 7°37'35''	25.0
	Meiganga	SepSep Djarandi	14°58'40'' 7°05'00''	30.0

Region	District	Name	Coordonnées (Long/Lat.)	Température (°C)
West	Manjo	Abang	9°45'50", 4°56'40"	25.2
	Bangen	Ahio-Ekanjo	9°41'30", 4°56'30"	28.0
	Mamfé	Ayukaba	9°08'50", 5°41'55"	28.6
	Bamenda	Bambui 2	10°15'25", 6°14'50"	26.0
	Mélong	Bare1	9°58'00", 5°00'35"	25.8
	Mélong	Bare2	9°57'20", 5°00'30"	26.5
	Mélong	Ebuku	9°58'10", 5°02'50"	26.4
	Bamenda	Fongakie	10°15'45", 6°03'25"	23.4
	Foumbot	Fossette	10°38'40", 5°29'25"	29.0
	Wum	FoundongMeteuf	10°14'20", 6°19'25"	25.0
	Foumban	Kuchuantium	10°38'55", 10°50'10"	23.8
	Foumban	Koutaba	5°36'45", 5°42'10"	24.4
	EkunduTiti	Lobe	9°05'25", 10°15'00"	49.0
	Nkongsamba	Manengouba	9°53'10", 9°55'20"	25.2
	Mélong	Mbuedum	4°51'20", 5°08'30"	24.6
	Mélong	Melong	9°59'05", 10°18'20"	26.6
	Wum	Ndi	5°9'45", 6°26'30"	25.2
	Bangen	Ndibisi	9°45'00", 9°46'10"	28.5
	Manjo	Ngol	5°06'00", 4°51'45"	31.0