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Research Article

Silica Sand Production Potential, Quality, and Market Analysis Case Study in the Kella Locality, South Sodo District, Ethiopia

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Abstract

Silica Sand is an essential input material in the manufacturing of sandpaper, glass materials, abrasives, polishing powders, heat-resistant materials (refractories), and bearings of precision instruments. This mineral is found abundantly all over the world, including Ethiopia. In Ethiopia, one of the foremost potential sources of silica sand is found in Kella locality, South Sodo District, Central Ethiopian Regional State; Kella, Ethiopia. The quarry site was one of the most significant site and considerable for the glass manufacturing industry as suitable to infrastructural advantage as of it was about 115Km far apart for capital of Addis Ababa, Ethiopia. This study addressed Kella site silica sand potential of New Era Mining S.C. From the study area about 15 points of sampling were taken for quality analysis by AAS testing. Accordingly, the physico chemical characterization and determination of total silica content was analyzed. Based on the atomic absorption spectroscopic analysis value for the silicate composition was examined. Hence, the average silica quality was 97.21% of purity from this industrial silica sand potentials area. This implies an enabling opportunity and is promising for investment of glass manufacturing plants in the area. The production and market demand of Silica sand has been addressed globally and by regional markets. In that 50.94% and 47.77% global export was led by Indonesia & USA during 2019, and 2020 respectively.

Keywords

Silica Sand, Mining, Production, Market, Global & Regional Trends'

1. Introduction

Ethiopia has significant potential to develop a state-of-the-art glass industry by leveraging its abundant silica sand deposits in regions like Mugher Valley, Haro Genda, Adigrat, Kella, and the Abay Basin [1]. The mineral Silica sand, a critical raw material for glass, cement, paint, plastics, abrasives, and other precision instruments, positions Ethiopia

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to capture a substantial market share in Northern and Eastern Africa [2]. Despite this, the production and development of industrial silica remains small-scale, with companies like New Era Mining PLC and factories such as Mugher Cement and Ethio-Hansom relying on limited extraction or imports [3].

To realize this potential, Ethiopia must address three key challenges: outdated technology, insufficient government support, and limited infrastructure [4]. Strategic investments in modern extraction and processing technologies, robust infrastructure, and supportive policies are essential to scale production, standardize quality, and achieve import substitution and export competitiveness. Developing the glass industry could drive economic growth, create jobs, and foster downstream industries like bottling and construction, while sustainable mining practices would ensure long-term resource availability [5].

2. Materials and Methodology

2.1. Materials

The materials used in this study included geological hammers, shovels, and digging chambers. Polyethylene terephthalate (PET) bags were employed for sample collection. Additional tools such as stationary markers, a mobile GPS device, and notebooks were utilized during the survey. Primary data were obtained from sixteen (15) representative samples, each averaging 2.5kg in weight. The sampling procedure followed a systematic-random approach within the designated site. The survey methodology involved traversing the study area, as illustrated in (Figures 2 and 4). After sample collection, each geospatial location was accurately labeled and correlated with qualitative silicate analysis. Silica sand processing in this study involved common purification techniques aimed at removing minor impurities. This process included crushing, grinding, and classification of natural silica sandstone. The treatment consisted of two main stages: a pretreatment phase followed by purification. Other techniques were reviewed discussed for future study and understandings.

2.2. Methodology

2.2.1. Study Area

The study area is situated in the Kella locality of South Sodo Woreda, in Guraghe Zone of the Central Ethiopia regional state. This assessment involved establishing observation points for geological mapping and collecting silica sand samples to evaluate the resource quality through physico-chemical analysis and laboratory testing. During the sampling and any physical information there was no related to human and animals performance, involved. Also none of the two (animals and human being) has been considered as element of sample, tasting result and related acts in this study.

During field observation, about 15 sample points were marked within the prime silica sand resource area, including one main mining site operated by New Era Mining S. C. Sampling sites of the proclaimed study area were designated during the primary sampling session as ‘Travel 1 Point 1 Sample 1’ through to ‘Travel 1 Point 9 Sample 9’ ($T_1P_1S_1$ to $T_1P_9S_9$). The secondary sampling session included additional representative samples labeled ‘Travel 2 Point 1 Sample 1’ through ‘Travel 2 Point 6 Sample 6’ ($T_2P_1S_1$ to $T_2P_6S_6$).

All samples were collected using field sampling technique of systematic sampling method, applying excavation by shovels and handpicking. In the sampling a systematic random approach had been employed that was adapted to suit the geographical conditions and pre-assessment plans outlined by the company for optimal accuracy.

Visual inspection of the samples showed that the sand was consistently white and homogeneous in color, suggesting a similarly bulk silica content across the study area.

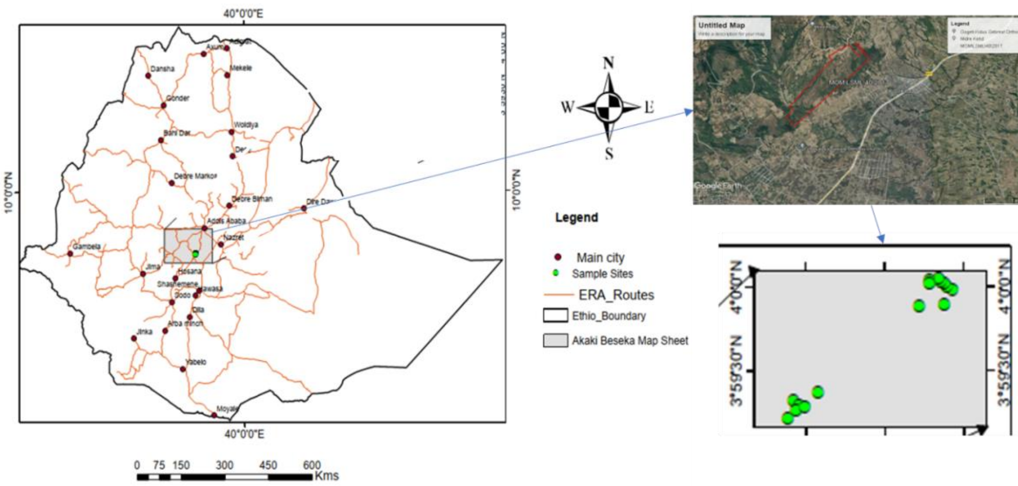

Figure 1. Location Map of Study area (Google Earth Map).

2.2.2. Geological Nature Study Area

New Era Silica Sand Mining S. C. holds a mining license for silica sand exploration and extraction in the Kella locality, Sodo Woreda, Guraghe Zone, Central Ethiopia regional state. The licensed area, covering approximately 1.42 square kilometers, that situated about 110Km to south of Addis Ababa. Geographically, the site lies within the central portion of the Ethiopian volcanic province, positioned at the geological contact zone between the Ethiopian Plateau and the western margin of the Central and Northern Main Ethiopian Rift Valley (MERV).

In the methodology, the Geological Setting was identified.

The regional geology of the license area includes a complex stratigraphy spanning multiple geological periods:

1) *Precambrian*: Basement crystalline rocks form the foundational substratum.
2) *Mesozoic:* Sedimentary sequences overlay the basement rocks.
3) *Paleogene (Late Eocene to Late Oligocene):* Fissured basaltic flows with subordinate Salic (silica-rich) volcanic layers dominate this interval.
4) *Pleistocene to Holocene*: The uppermost units comprise basic to felsic volcanic and phreatomagmatic deposits interceded with lacustrine and alluvial sediments.

A. Resource Exploration

Preliminary fieldwork involved removing a 10–50cm overburden layer and collecting silica sand samples from outcrop surfaces using a shovel, stored in labeled plastic holders. Initial chemical analysis of regional deposits indicates high silica content (~96%), suitable for glass manufacturing, foundry sand, and abrasives. These findings highlight the need for systematic studies to confirm resource quality and optimize mining strategies.

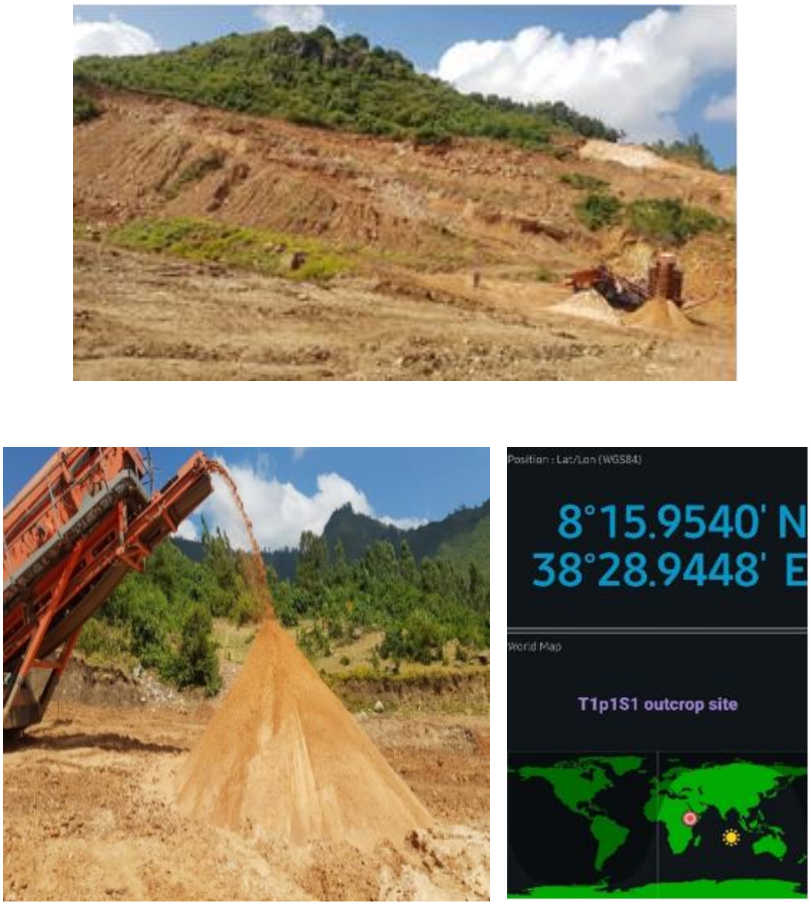

Figure 2. *New Era Silica Sand Mining S/C Main site (left), and its Geospatial location in sampling path (right).*

In this study there was two scenarios' in collecting the representative items, namely the first and second path of sampling phase were done according to the systematic sampling approach: It has been taken with average depth of 10-50cm for each sample points.

Combined samples of about 16 items were collected from Site of New Era mining plc. Samples were transported to the geo-chemical laboratory, Geological Institute of Ethiopia, Ministry of Mine; in plastic bags free of any contamination at room temperature. At each Silica Sand sample collection GPS map were taken by Mobile GPS application.

Figure 3. *Silica sand Samples for complete silicate analysis.*

B. Sampling Site

The total samples from both tracking's ($T_1P_1S_1$ up to $T_1P_9S_9$ and $T_2P_1S_1$ up to $T_2P_6S_6$), Collective samples of about 16 items were together from Site of New Era mining PLC samples were transported to the geo-chemical laboratory in Geological Institute of Ethiopia, Ministry of Mine; in plastic bags free of any contamination at room temperature. At each Silica Sand sample collection GPS map were taken by Mobile GPS application.

(a)

(b)

(c)

Figure 4. *Sapling points $T_1P_1S_1$–$T_1P_9S_9$ (a) and (b); $T_2P_1S_1$–$T_2P_6S_6$ (c) and The Map of Sample positions on Mobile GPS.*

2.2.3. Apparatus and Instrumentation

Shovels, polyethylene terephthalate (PET) bags, Markers, level paper, and GPS devices were materials used in the study. Other important laboratory equipment's included were; furnaces, volumetric glassware, and magnetic stirrers. Atomic Absorption Spectroscopy (AAS), integrated with computer systems, was utilized for elemental analysis and data recording.

2.2.4. Sample Preparation for Silicate Analysis in Testing Laboratory

A. Size Reduction

Parceled samples (rock type) were crushed by jaw crusher up to compatible to 200 mesh size, of 0.75 micrometer. For further seized reduction have been taken on milling machines; in the Geo-chemical laboratory under floor sides there uses balance for weighting and after grinding and rock sample converted to compatible and reduced size up to 0.75 micro gram.

(1) Silica Sand Samples Collected from New Era mining S.C quarry site

(2) Analogue Balance for rocky Sample weighing

(3) Jaw crusher for size reduction

(4) Crusher for fine size reduction

(5) Milling machinery for powdering the Samples powder

(6) Analytical balance for fine sample weighing

(7) Volumetric Flask / Glass wares for samples preparation to AAS analysis

(8) AAS for major oxides in Silica Sand determination

Figure 5. *Instrumentation and apparatuses used in geo-chemical laboratory for Silicate analysis.*

B. Organic Carbon Removal

Powdered silica sand was crushed, milled, and screened through a 200-mesh sieve (0.75 μm). A 0.1 g sample was mixed with 0.5g lithium tetra-borate and 1g lithium meta-borate in a platinum crucible. The mixture was heated at 950℃ for 45 minutes to eliminate organic carbon. After cooling, the crucible was soaked in 5% HNO_3 solution overnight (>12 hours) for digestion and complete organic carbon removal.

The sample was rinsed with distilled water on a 105℃ hot plate with magnetic stirring until separated. The solution was diluted to 500ml, with 1.5ml lanthanum chloride ($LaCl_3$) added to control interferences. Major metallic ions (Ca, Mg, K, Na, Al, Fe, Mn) were analyzed by Atomic Absorption Spectroscopy (AAS) for silicate characterization and oxide quantification [6].

2.2.5. Silica Sand Production Technology

A. Raw ore Treatment

The raw silica sand excavated from the source shall be undergoes certain pretreatment steps. The Jaw crusher is used to crush natural silica sandstone into pieces. Then, wet grinding is carried out in grinding equipment to require smaller particle size. The wet grinding can remove the dust produced and attached impurities (such as iron oxides and hydroxides) through rubbing against each other [5]. Then, grind products enter classification operation.

B. Classification

There are three principal techniques which may be used in combination with each other; screening, hydro-cyclones and hydrosizer [7]. Screens or hydro-sizers can separate sand at a 0.5mm grain size cutoff for glass sand production. Hydro-sizers use water currents to create a teeter state, sorting heavier grains to the bottom and lighter ones to the top. Compared to hydro-cyclones, hydro-sizers yield better grading and fewer fines in the sand processing plant. Using hydro-sizers in series allows production of well-controlled graded sands [5]. For high-quality silica sand, additional washing plant processing is required.

C. Preliminary Cleaning and De-watering

The treated raw ore can enter the screw sand washer for preliminary cleaning and de-watering, and some impurities can be removed. At the same time, de-watering is carried out, so that the concentration of quartz sand slurry reaches 60-70%, which is preparation for the subsequent scrubbing operation.

2.2.6. Silica Sand Purification Process

A. Scrubbing and DE sliming

Silica sand from the pit is screened to remove oversized material using stationary, revolving, or vibrating screens. The undersized sand is washed and dewatered in a spiral classifier, or occasionally cone, centrifugal, or rake classifiers [8]. To clean sand grains, heavy-duty scrubbing removes iron films, binding, and clay impurities through mechanical and abrasive forces, breaking down unconsolidated mineral aggregates [9]. After scrubbing, classification further purifies the silica sand by removing residual impurities and grinding unconsolidated aggregates [10].

B. Attrition Scrubbing

The Attrition scrubbing techniques uses opposing slurry flows with 70-89% solid concentration to maximize particle impact, removing coatings from silica grains for high-grade uses like glass. Though, the process consumes high power and is costly, in generating fines which are removed physically or chemically [2].

2.2.7. The Removal of Silica Sand Contaminants

a) *Overview of Contaminants*: Silica sand contaminants, such as refractory materials (chromite, titanium oxides) and iron oxides and sulphides, are undesirable due to high melting points and processing resistance, with iron within sand grains being particularly difficult to remove [11]. Methods like gravity separation, flotation, and magnetic separation are used to remove free iron particles [1].

b) *Heavy Metal Separation (Including Iron Oxides)*: Gravity separation (spirals) separates high-density iron particles cost-effectively but requires multiple passes. Froth flotation uses additives to remove hydrophobic heavy minerals under acidic conditions, though it involves high reagent costs and environmental concerns. Magnetic separation effectively targets iron oxides but may need complementary methods for non-magnetic contaminants.

c) *Magnetic Separation*: Magnetic separation, using wet and high-gradient separators, removes iron impurities like hematite and magnetite with low operating costs and environmental impact, requiring two to four passes for desired purity, but it cannot address non-magnetic minerals like rutile [5].

d) *Chute Gravity Separation*: Spiral chute gravity separation removes non-magnetic heavy minerals like zirconia based on specific gravity differences, enhanced by mineral morphology, separating granular heavy minerals, silica sand, and flaky/light minerals [4].

e) *Flotation Separation*: Flotation removes mica and other impurities through a three-stage process targeting iron-containing mud, mica, and feldspar, requiring finer grinding for quartz-gangue dissociation [12].

f) *Acid-Washing*: Acid leaching at low pH dissolves metal oxides, achieving ~92% Fe_2O_3 removal with hydrofluoric and hydrochloric acid, though it is time-consuming (10–40 days) and environmentally impactful, mitigated by alkaline washing and ultrasound irradiation [11].

2.2.8. Drying

a) *Drying Requirements*: Foundry and glass sands require drying to meet quality specifications, while leisure, sporting, and horticultural sands typically do not, except for wax-coated equestrian sand [1]. Drying is energy-intensive and costly, so it is avoided at most processing sites.

b) *Drying Methods*: Open-air drying, often combined with screening for uniformity, is the most common and cost-effective method, with sunrise/open-air drying preferred for its simplicity and lower cost compared to mechanical drying.

Hence, silica sand processing involves screening (to remove oversized particles), washing and dewatering in classifiers, heavy-duty scrubbing (to remove iron films and impurities), and classification to purify sand.

Gravity separation is cost-effective but requires multiple passes. Froth flotation is effective but costly; magnetic separation targets iron oxides, and attrition scrubbing addresses iron staining, though encapsulated iron remains challenging. Even though, these are best techniques in the processing of silica sand there are certain challenges:

2.2.9. Challenges in Impurity Removal

The presence of impurities in production of silica sand, were determined. Some common and abundantly affecting challenges due the presence of impurities were mentioned bellow.

1) *Mica Minerals*: Spiral chute separation cannot fully remove various mica types due to its reliance on density differences.
2) *Feldspar Minerals*: Spiral separation is ineffective for feldspar, which has a similar specific gravity to quartz, requiring flotation. *Monomer Dissociation*: Finer grinding is needed for effective quartz-gangue dissociation to improve separation efficiency.

Three-Stage Flotation Process for Silica Sand

1) Iron-Containing Mud Removal: In a neutral or weakly acidic environment, reagents float iron-containing mud from the slurry.
2) Mica Removal: In a neutral or weakly acidic environment, reagents target mica and mica-quartz aggregates for flotation.
3) Feldspar Removal: In a neutral or weakly acidic environment, reagents float feldspar and feldspar-quartz aggregates.

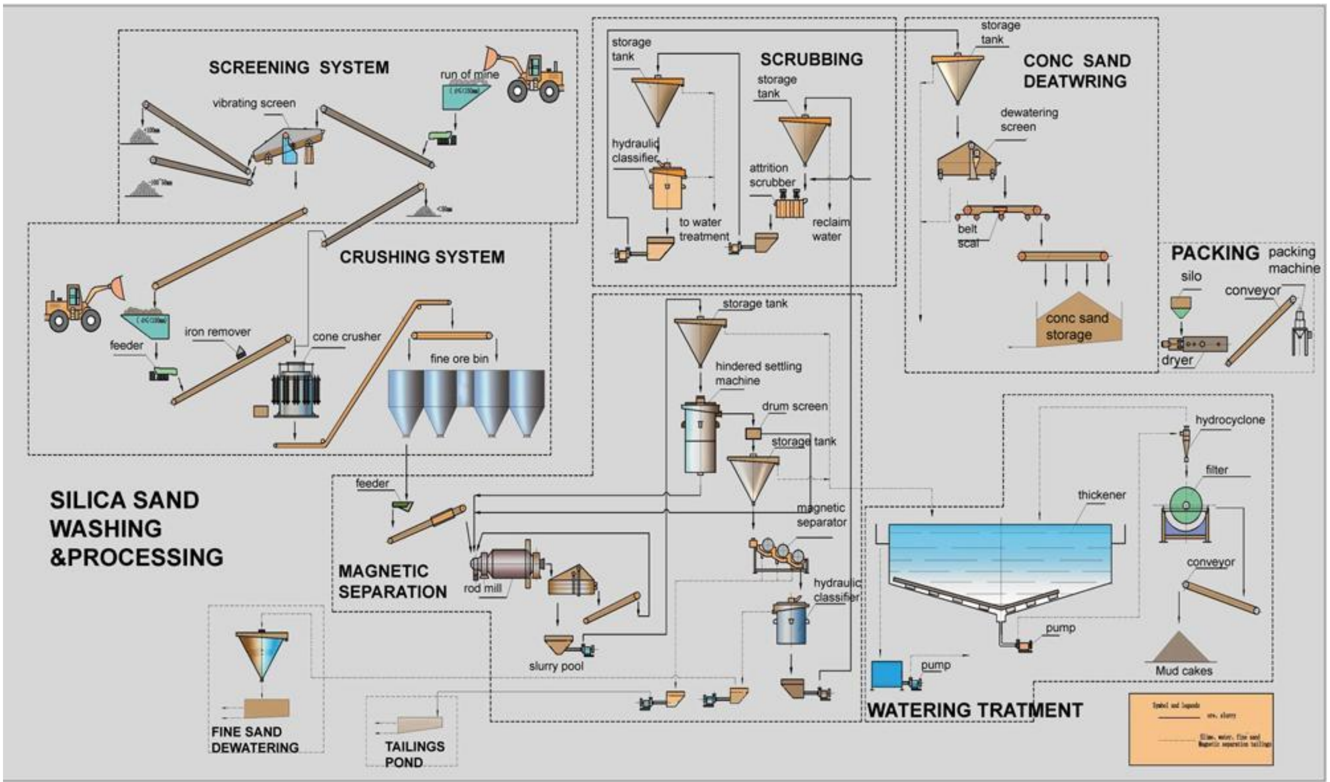

Figure 6. *Silica sand processing and washing plant [3, 13].*

2.2.10. Contents of Correction and Clarification

The global contents of correction clarified that flotation targets on mica-quartz and feldspar-quartz aggregates, replacing ambiguous terms like "concatenation" and "conjoined body" [14]. These can be categorized as bellow, due their operational scheme:

1) Emphasize finer grinding for monomer dissociation to enhance separation.
2) Specify neutral or weakly acidic flotation environment for consistency.
3) Correct "Reagent system flotation" to "Reagents target" for clarity. This process enhances silica sand purity for

glass production by removing mica, feldspar, and iron impurities.

3. Results and Discussion

3.1. Result of Complete Silicate Analysis

The Silica Sand production of New Era mining s. c, existing at Kella locality: used a combination of mobile crushers and with its limited washing plant. The New Era Silica Sand Mining S. C; its feasibility study up to the project level has owned promising operational situation. Though, there has limitation on market side of its industrial Silica Sand production. This market gap would be from both governmental and private stakeholders lack for the uses, essential application and demand to supply crumbling. The research team was focused on specialty of the quality and quantitative aspect of Silica Sand for the potential resource and reliability of the silica sand for the industry's required it for their vital input.

Based on the experimental results of these representative samples undertaken in the geochemical laboratory of the Geological Institute of Ethiopia (GIE), Atomic Absorption Spectroscopy (AAS) outputs proved that the silicate content of the samples was described as shown in Table below. Experimental result provided that, about seven major metallic oxides (Al, Ca, Fe, Mg, Na, Mn, and Ti) and four non-metallic oxides of Si, P, water vapor and loss of ignition (LOI) was determined by AAS value.

The silica quartz (SiO_2), followed by Iron content (Fe_2O_3), with some phosphors and Titanium oxides (p_2O_5 & TiO_2) respectively and water vapors (moisture content), with loss of ignition (LOI) were numerated per the AAS analysis. Other metallic oxides, such as except Al_2O_3 (except travel 1-path-1 samples 1 and 4), K_2O, and MnO, and others were below the detection limit (<0.01%). This implies the significant purity of Silica Sand by composition with a low percentage of oxides of major alkalis and trace impurity rendering for the promising future uses. Similarly, amount of CaO (0.26 – 1.34%), whereas the Silica Sand content was recorded accordingly 97.21% on average.

***Table 1**: Result of Total Silicate analysis (from AAS Determination).*

Sample ID. (Field No.)	Percentage composition of major mineral constituents (AAS Spectroscopy Result); a Characterized mineral composition per sample of Silica Sand											
	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	NaO	K_2O	MnO	P_2O_5	TiO_2	H_2O	LOI
MIDI - T1P1S1	94.20	1.82	0.26	<0.01	0.04	<0.01	<0.01	<0.01	0.13	0.08	0.37	2.16
T1P2S2	98.46	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.08	<0.01	0.03	1.17
T1P3S3	97.98	<0.01	0.38	<0.01	0.02	<0.01	<0.01	<0.01	0.01	0.05	0.28	1.18
T1P4S4	95.86	0.17	0.6	<0.01	<0.01	0.04	<0.01	<0.01	0.09	0.08	0.38	1.76
T1P5S5	96.94	<0.01	0.66	<0.01	<0.01	<0.01	<0.01	<0.01	0.11	0.05	0.59	1.30
T1P6S6	98.42	<0.01	0.66	<0.01	<0.01	<0.01	<0.01	<0.01	0.11	<0.01	0.3	0.52
T1P7S7	97.46	<0.01	0.44	0.26	<0.01	<0.01	<0.01	<0.01	0.09	0.01	0.33	0.57
T1P8S8	97.44	<0.01	0.5	<0.01	<0.01	<0.01	<0.01	<0.01	0.09	0.04	0.34	0.46
T1P9S9	99.00	<0.01	0.22	<0.01	<0.01	<0.01	<0.01	<0.01	0.08	0.01	0.25	0.55
MIDI -T2P1S1	97.92	<0.01	0.26	0.34	0.1	0.38	<0.01	<0.01	0.12	<0.01	0.34	0.85
T2P2S2	97.50	<0.01	0.32	<0.01	<0.01	<0.01	<0.01	<0.01	0.1	<0.01	0.58	0.58
T2P3S3	93.72	<0.01	0.8	1.34	0.52	1.24	<0.01	<0.01	0.13	<0.01	0.25	0.29
T2P4S4	97.74	<0.01	0.62	0.26	0.1	0.56	<0.01	<0.01	0.12	<0.01	0.31	0.37
T2P5S5	97.72	<0.01	0.74	<0.01	0.16	<0.01	<0.01	<0.01	0.11	<0.01	0.18	0.43
T2P6S6	97.84	<0.01	0.8	0.66	0.16	0.56	<0.01	<0.01	0.13	<0.01	0.27	0.43
Average	97.21	1.00	0.52	0.57	0.16	0.56	<0.01	<0.01	0.10	0.05	0.32	0.84

In (Table 1) above, average value of Silica Sand (SiO_2) was 97.21% purity; which implies coming industries of glass manufacturing and others necessitating quality Silica Sand would invest in proud for the utilization of these abundant resources.

This assessment study may require further elaboration about composition, transportation, technology utilization and demanding method for silicate analysis experiment. Also, the production processing, technology and skilled man power on the detail application, uses esthetic values of silica sand potential in Ethiopian is yet recognized.

3.2. Market of Silica Sand and Its Production

3.2.1. Silica Sand Supply in Ethiopia

In Ethiopia, local silica sand production for the years between 2003 up to 2013 was presented in (Table 2) below. Accordingly, the production of industrial silica sand in 2013 increased on an estimated level of 371% compared with that of fiscal year 2012. In 2008, Ethiopia Hansom International Glass PLC (a joint venture of CGC Overseas Construction Ltd. and China-Africa Development Fund) had been acquired a silica sand mining license. The company had started mining of silica sand near Lemi locality in Amhara National Regional State. In addition, Daylight Applied Technologies, Addis Ababa Bottle and Glass Factory and Allied Chemicals PLC had been utilized their silica sand quarries at Alem Ketema, Mugher and Lemi localities, respectively. Allied Chemicals had produced sodium silicate and export the product to various countries [4].

Table 2: Local production of silica sand in Ethiopia (2003-2023)

Year	Production (Metric ton)	Growth (%)
2003	5,400	-
2004	4,550	-16%
2005	5,099	12%
2006	5,099	12%
2007	5,699	6%
2008	6,032	9%
2009	6,546	369%
2010	30,700	129%
2011	70,250	-90%
2012	7,000	-
2013	33,000	371%

Based on the data a significant fluctuation growth rate on the years indicates unstable production trend. The decline and recovery in the years 2003 -2006 suggested that, declined production by 16% on 2004 (from 5.4 to 4.6 metric ton, and recovery of the production rate on 2005 and 2006 (with 12%, stabilized to about 5,099 metric tons.

The steady growth (2007 -2008) as moderately 6% and 9% respectively gradual growth of silica sand production and reached about 6,032 metric ton. Irregularity of data points in 2009 – 2010, a dynamic growth 369% (6,546 metric ton) followed by 129% (30,700 metric ton) suggesting the market demand and new flat glass production establishment in Ethiopia.

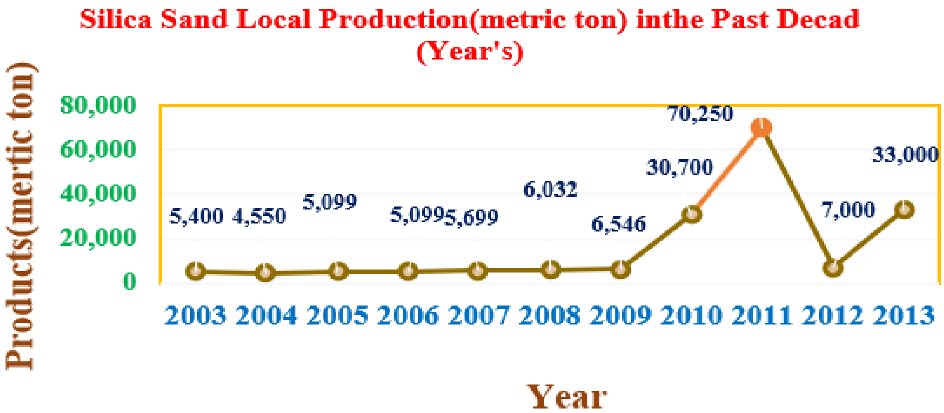

Figure 7. Volume (in metric ton) of industrial Silica Sand Local production (2003 -2013).

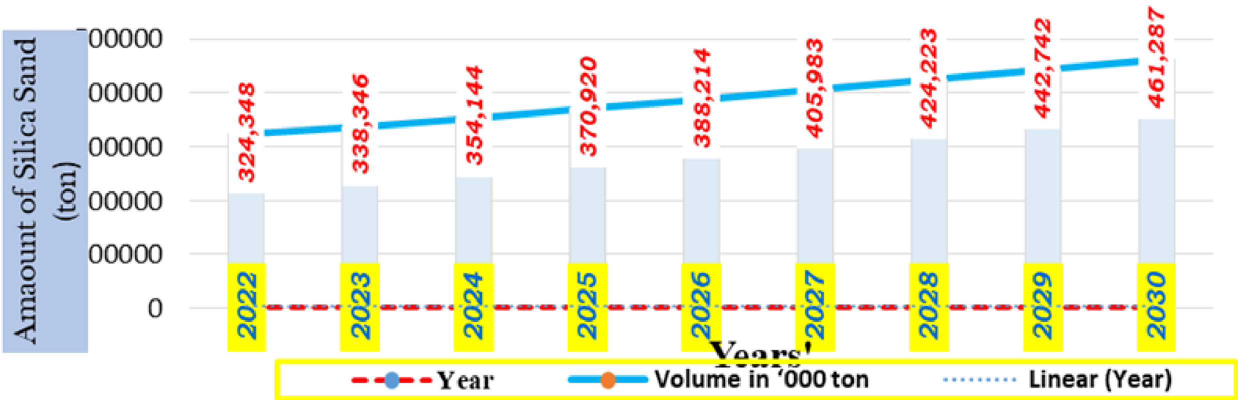

Figure 8. The growth curve of industrial Silica Sand local production (2003–2013).

Steady decline from 2011 and 2012 growth rate was failed on -90%; these from 70, 250 to 7,000 metric ton of silica sand were severing contraction by possibly economic and operational or external failure. On the contrary, robust growth by 371% of the 33,000 metric ton on 2013 had been a strong correction of the production and improved condition as good recovery anomalies. In general, extreme volatility of the production growth from -90% to 371% indication of potential inconsistency for production of silica sand and -90% was leading to potential production correction. The spike data in 2009–2010 and 2013 has been possibly due to some external influences like policy changes, market shifts, production capacity or any other factor driving extreme fluctuations.

3.2.2. Silica Sand Demand in Ethiopia

Due to lack of standard silica sand in Ethiopia, the country is forced to import industrial silica sand for various industrial applications. Industrial Silica sand imported in fiscal year 2015 increased by 60% compared with that of fiscal year 2014. The imported amount of silica sand was mainly for the purpose construction and industrial sector.

The increase in the import shows that the local producers can't satisfy the local demand silica sand utilizing companies in Ethiopia. Therefore, in year 2015, of Ethiopia imported silica sand of about 58% and 34% was Italy and India respectively.

Table 3: Imported silica sand from abroad (2017- 2023).

Country of Origin	Amount in Ton
Bahrain	160.10
Belgium	9.00
China	133.50
France	399.96

Country of Origin	Amount in Ton
Germany	8.18
Indian	2,902.77
Italy	3,110.39
Saudi Arabia	289.25
Spain	20.20
Sweden	20.00
United Arab Emirate (U. A. E)	288.27
Total	7,341.62

Source: ECRA/ now Ethiopian Custom Commission imported quartz silica sand 2017-2023.

According to the Figure 7, below; the first three major silica sand exporting countries are Italy, India and France respectively, followed by Saudi Arabia and united Arab Emirate (U.A. E) in the year 2011 -2015.

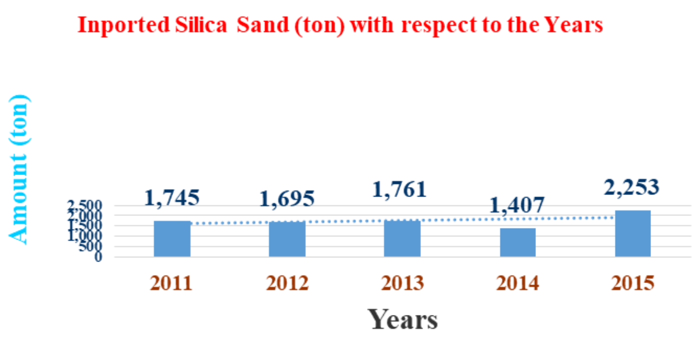

Figure 9. Imported Silica Sand for Local Consumption in Ethiopia.

3.2.3. Global Market of Industrial Silica Sand

Geographically, the global silica sand market is categorized into North America, Asia Pacific, Europe, Latin America, and Middle East, and Africa. Among these, the market is dominated by East Asia followed by North America on account of major consumption of Silica Sand.

Table 4. Industrial silica sand consumption by regions

Region	Production '000 Ton	Consumption '000 Ton
North America	112,500	87,667
Latin America	6,660	10,848
Europe	141,360	3,896
East Asia	11,260	106,138
South Asia & Oceania	37,060	34,011
Middle East & Africa	18,260	15,540

The Asia Pacific silica sand market was expected to witness lucrative growth opportunities on account of the increasing demand from glass making and other end use industries especially in the developing nations of India, China, and Japan. Global industrial silica sand demand has increased on an average of 4% per year to reach 293.2 million tons during the year's 2015 & 2019; and in the time valued about 11.1 billion USD as shown below Table 5.

Table 5. *Global demands of industrial Silica Sand (2015 – 2019)*

Year	Volume ('000 ton)
2015	251,879
2016	261,031
2017	271,006
2018	281,832
2019	293,200

The global demand for industrial Silica Sand was forecasted to reach 4.4% per year to 461 million metric tons in 2030, with a value of USD 20.7 billion (Table 6).

The growth mainly attributed to a mounting demand in building and construction, glass, foundry and other industrial sectors

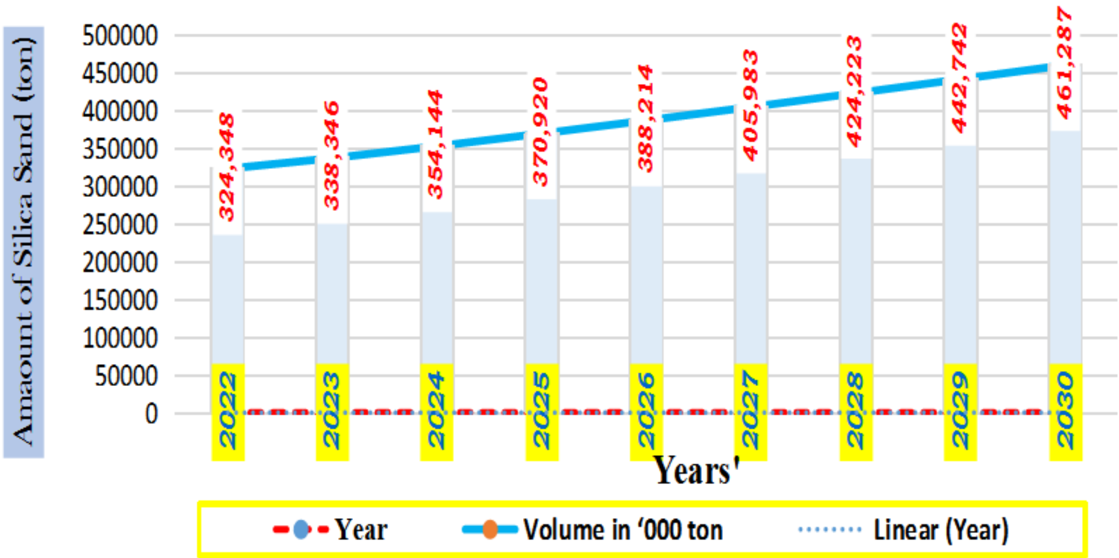

Figure 10. *Forecasted silica sand demand (per ton) on global market.*

3.2.4. Production & Market of Silica Sand by Regional Bases

The East Asia region was the largest consumer of industrial silica sand amounting 106 million tons on the year 2019. This is due to the huge demand in the glass and vehicle (aluminum and metal casting in the vehicle industry) industry in China, Japan, India and Korea. The East Asia region was followed by North America (87.7 millon tons) and Europe (39 million tons).

Table 6: Silica Sand major Importer countries worldwide on (2019 & 2020).

Year	Countries	Value, US$ (Million)
2019	China	46.4
	United Kingdom	5.98
	Cote D'Ivoire	4.5
	Norway	3.42
	Palestine	3.25
2020	China	202
	Canada	174
	Japan	101
	United Arab Emirates	63.9
	Germany	58.1

Similarly, the regional silica sand importers across the world were reviewed. Hence, top regional importer countries were China, Canada and Japan on the year 2020 in related to their goods and service of glass and related manufacturing world leading market.

Whereas major exporter of silica sands and quartz sands in 2019, (top two exporters were Malaysia & Indonesia) and in a year 2020, mainly United States & Australia) were as shown below tables.

Table 7. Silica Sand Exporter major countries worldwide in (2019 & 2020).

Year	Countries	Value, US$ (Million)
2019	Malaysia	31.1
	Indonesia	20
	China	4.66
	Jordan	2.77
	France	2.52
2020	United States	363
	Australia	165
	Belgium	98.7
	Germany	68
	Malaysia	65.2

Source: Reference document to cite: Gaulier, G. and Zignago, S. (2010) BACI: International Trade Database at the Product-Level. The 1994-2007 Version. CEPII Working Paper, N°2010-23. BibTex.

From Table 7 above; Malaysia and Indonesia are 1st (50.94%) and 2nd (32.76%), were most beneficiary state by exporting industrial standard silica sand across the world in global silica sand market on 2019. China was a 3rd exporter of industrial silica sand with (7.63%) of global market on the year 2019. Whereas, United states and Australia were 1st and 2nd leading exporters of industrial standard Silica sand across the world on 2020 for global marker demand. Accordingly, 47.77%, 21.71% and 12.99% of the major global industrial silica sand had been exported by USA, Australia and Belgium respectively on the year 2020.

3.3. Conclusion

From the data above industrial Silica Sand resources in Kella locality is big potentials for the supply chain-based investment of glass industries in the future. This is because, locally produced flat glass production is still under the enormous gap and yet unsatisfying for the national demands. The resource in the study area may need further improvement on production technology, quality control and value addition (by sieve size, type and amount for different demanding companies). The need with enabling capacities of mass production for satisfying the local market consumption is becoming customized.

On the other hand, some very few glass industries in Ethiopia have their site for raw materials; and hence the New Era Silica Sand mining s. c has market shortage. To expand this good opportunity a short-listed companies shall be attracted to this new opportunity. Even though; the research group was tried to assess standard Silica Sand manufacturers, but no one company have tried to use this opportunity for the primary occasion. It is promising for the specialization product categories for local market and also for the export market. Accordingly, the result confirmed from experimental analysis is had been done in geochemical laboratory; on average silica sand quality is 97.21% implies the pure industrial silica sand. This encourages the promising investment on glass industries would be sustainable on raw material side, and the market plus basic infrastructure.

3.4. Recommendation

New Era Silica Sand Mining S. C., established in 2015 by Federal mining license, has focused on exploring high-quality silica sand in Kella locality, Sodo Woreda to meet local glass industry demands. As of concluded by on-site observations, and engagements thereof the company conducted sampling and tested silica sand using (AAS) to assess its quality. Despite these efforts, and challenges, including limited production capacity and gaps in manufacturing standard-grade silica sand. The following areas require further research and action to address these issues: *Comprehensive Reserve Assessment:* though a rough rule of regional deposit analysis shows ~96% silica (SiO_2) content, ideal for glass, foundry sand, and abrasives. Systematic studies needed to validate resource quality and optimize excavation. It requires conducting detailed studies to quantify silica sand reserves in Kella and across Ethiopia.

Investor Engagement: Promote investment by demonstrating the operational and economic benefits of advanced silica sand processing technologies for industrial applications.

Simplified Processing Methods: Develop cost-effective treatment techniques (e.g., washing, screening) to produce standard-grade silica sand suitable for local cement industries.

Government Support: Secure foreign currency access to procure machinery, spare parts, and tools for enhanced production.

Industrial Park Development: Establish a multi-purpose silica processing facility at the New Era site to supply inputs for ceramic, glass, and other industries.

Abbreviations

AAS	Atomic Absorption Spectroscopy
CEO	Chief Executive Officer
ECRA	Ethiopian Revenue and Customs Authority
GIE	Geological Institute of Ethiopia
GPS	Global Positioning System
LOI	Loss of Ignition
MERV	Main Ethiopian Rift Valley
MIDI	Mineral Industry Development Institute
ORCID	Open Researcher and Contributor
PET	Polyethylene Terephthalate

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Data Availability Statement

All data generated or analyzed during this study are included in the manuscript text.

Conflicts of Interest

The authors declare no conflicts of interest.

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