Geologyand Weathering Indices of the Bedrocks and Sediments in Okemesi - IjeroArea, Southwestern Nigeria

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Abstract
Geological field mapping of the rocks in Okemesi-Ijero area were carried out at a scale of 1:50,000 to determine the underlying lithologic units and petrological characteristics. Also the suitability of the rocks and sediments for geochemical exploration purposes were determined using weathering indices parameters such as chemical index of weathering (CIW), weathering index of Parker (WIP), Plagioclase index of Alteration (PIA) and chemical index of Alteration (CIA). Thirty-five bedrocks and stream sediment samples were collected from various locations within the studied area using grid-controlled sampling techniques. Field studies revealed that the sediments were derived from weathering of the bedrocks such as quartz-biotite-schists, banded gneisses, granite-gneisses, biotite gneisses, calc gneisses, porphyritic granites, charnockites, massive/schistose quartzites and mica schists which are the dominant lithologic units in the studied area.The weathering profiles based on the above parameters showed that sediments from River Elewu and Issa 7c are weakly weathered whereas, sediments from Agbagbara, Ede-1, Ede-2, Effon-Okemesi-2, Esa-Oke-2, Odo-OWaAbidogun, Ofale road, Okemesi-2, 3 and 9 were intensely weathered which makes them unsuitable for geochemical exploration work due to complete weathering of the mineral grains.

Keywords*:* Okemesi; Ijero: Lithologic units: Sediments: Weathering Indices

1. Introduction

A range of media including stream sediments, soils and waters have been used in many countries and across different scales for geochemical mapping (e.g. Darnley, 1990; BGS, 1990; Riemann and Caritat,1998; Rice, 1999; Key; De Waele; Linyungu, 2004; Johnson, Breward and Ander, 2005).Stream sediment is a composite of the products of weathering and erosion derived from the catchment basin, and funneled into and along the stream channels. Very fine grained sediments tend to have assemblages rich in zircon which is a result of weathering and sorting from source rock and not of the pressure of zircon-rich source rock. This implies that a regional distribution pattern of heavy minerals is due to various weathering process in source rock and not due to differences in the source.

Geological mapping is the main and one of the basic techniques of gathering geological information on the field where rocks can be observed in-situ. This leads to understanding the geological events of an area or terrain. As disintegration sets in into rocks be it physical or chemical, the aggregates of minerals in the rock are broken down into different fractions which end up in streams and river channels. Stream sediments originate from near the surface of exposed rocks of igneous, sedimentary and volcanic origin. Some of these are easily eroded whereas; others such as crystalline and metamorphic rocks are affected by stream only when exposed.However, the rocks in the studied area are highly weathered making it difficult to identify minerals and possible geologic structures that could be used to determine the geologic history as well as collection of fresh rock samples.Lots of literatures abound on the various investigations carried out in the study area and related works outside the study areasuch works include geochemical dispersion of gold in stream sediments in PaleoproterozoicNyong series, southern Cameroon was also undertaken by Mubfu*et al.,* (2014) in an attempt to explore for gold using stream sediments collected in the Ngo Vayang area of southern Cameroon, the study revealed that the Au-Hf element association from the R-mode factor analysis indicated gold mineralization while U-Th-Pb-W, Nb-Ta-Co-V, Au-Hf-Cu associations reflected lithologic controls. Akintola*et al.,* (2013) carried out the petrography and stream sediment geochemistry of Ede and its environs in order to identify the rock units with their mineralogical appraisal and to determine the concentration and distribution of major and trace elements in the stream sediments with a view to elucidate the mineral potentials of the study area. Emmanuel *et al.,*

(2011) carried out geochemical investigation of the southern part of Ilesha with the aim of clarifying the potential source of mineralization in the area. Geologic mapping of the area revealed that the area is made up of different lithologies such as undifferenciatedschists, gneisses and migmatites with pegmatites, schists and epidiorite complex, quartzite and quartz schist. (Olaolorun and Oyinloye, 2010; Oyinloye, 1997; Rahaman*et al*,(1988) and according to Oyinloye and Adebayo (2005), the migmatite-gneiss complex in Ijero area is composed of a mafic portion made up of biotite, hornblende, quartz and opaque minerals, while the felsic portion is qartzo-feldsparthic. Other rocks identified by these authors are charnockites, metasediments composed of amphibolite schist, mica-schist and quartzites. Fadipe (1988) also showed that most of the pegmatites in Nigeria especially at Ijero and their environs are associated with cassiterite-tanatlitemineralizations which are found associated with migmatite-gneiss and amphibolites.However, this study attempts to unravel the petrological character of the different rock units in the studied area, and carryout geochemical assessment of the bedrocks and sediments for mineral exploration using weathering indices and parameters.

Location and Accessibility

The study area lies within latitudes 7^0 45'N and 8^0 00'N and longitudes 4^0 52'E and 5^0 08'E. It covers part of the topographic map sheet No. 243 (Ilesha N.E. 1:50,000) and sheet No. 244 (Ado N.W. 1:50,000).The study areas cover parts of Ekiti and Osun, southwestern Nigeria with a total surface area of 821.4km^2 (Fig.1). Major towns in the area include Okemesi and IjeroEkiti. Other towns include Epe, Ikoro, Effon, Ipoti, odo-owa, Ayegunle, while those in Osun State are Oke-ila, Ilupeju, Edemode, Orangun and Oba-sinkin .The areas which fell within Osun, Southwestern Nigeria can be rated moderately motorable due to interconnectivity of roads, while areas within Ekiti can be rated poor because there are only minor roads and footpaths which are not motorable. Localities within Ekiti are mainly small villages with linear settlement along the road, while nucleated settlement predominates in Osun. The study area is generally accessible through network of all seasonal roads and motorable tracks which links it with other part of the country.

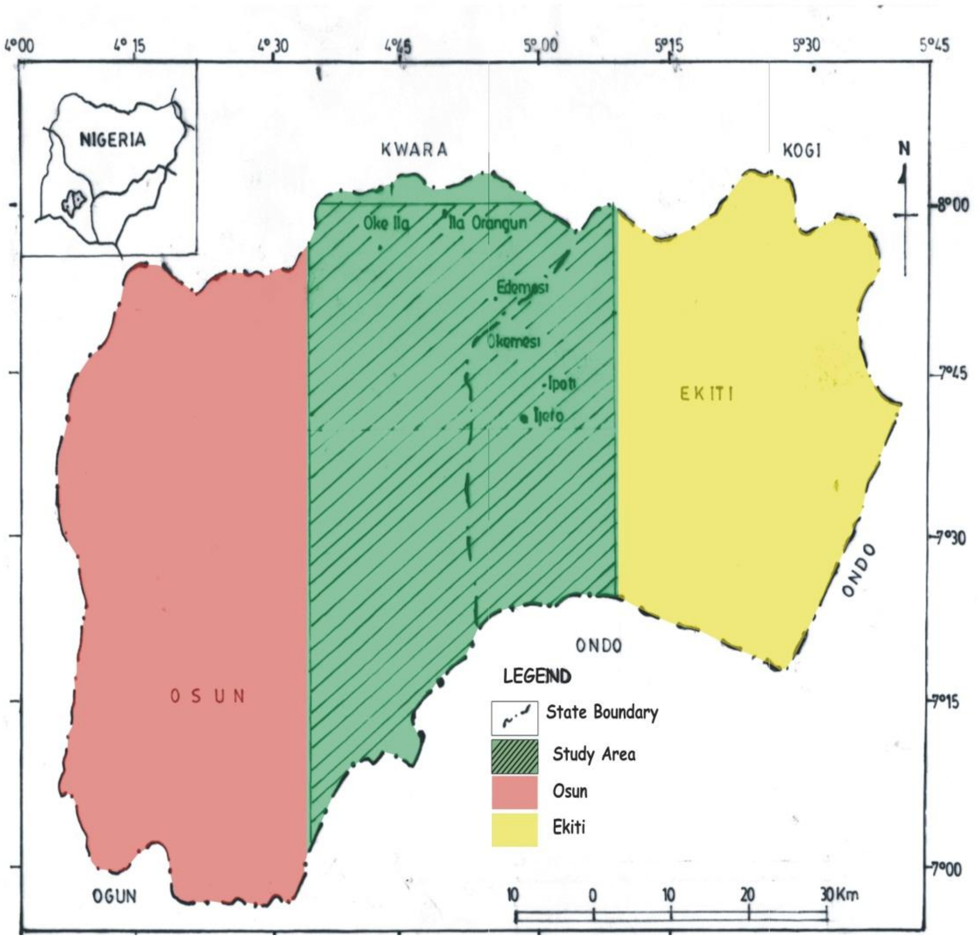


Fig.1: Map of Osun and Ekiti, southwestern Nigeria showing the study area (inset: Map of Nigeria showing Osun and Ekiti States).

Geology of the study area

The various lithologic descriptions of the different rocks mapped in the study area are discussed below.

Banded gneisses

This lithology covers the southwestern part of the study area around Okokoro, Aba Francis and Aba-Ori-Apata near IkoroEkiti. Texturally, they are medium to coarse grained with alternating bands of light and dark coloured portions of about 3cm thickness with complete gradation between them. They occur as low lying outcrops which have been intruded by pegmatite in the south eastern corner of the area. The rock consists of alternating felsic and mafic minerals and structures like banding, microfolds and fractures were noticed on the outcrop. They have whitish grey tones.

The samples mapped around Okemesi and Ipoti are medium to coarse grained and are foliated and display compositional banding of the mafic and felsic minerals. The rock strikes at 333^0 and dips at 60^0W.The mineralogy consist of quartz, biotite and orthoclase and microcline feldspars.

Quartzites

These tend to form good topographical features which rise up to about 400metres above the surrounding terrains forming ridges. Quartzites cover the northern part around Oke-Ila, Ilupeju areas to central, western (Ayegunle), extending to the southwestern and southern parts of Okemesi (Ajindo) of the study area. Around the study area, the varieties of quartzite encountered are massive, milky, smoky, sugary, ferrugineous and schistose quartzites. However, schistose, ferrugineous and smoky varieties are the commonest in Okemesi area. The massive quartzites are not foliated but hard and are compact, the schistose quartzites are foliated and exhibit alternations of felsic mineral such as quartz and mafic mineral such as biotite with planar fabric. The milky ones have milky appearance by inspection and developed slickenside surfacesn with specks of muscovite. The smoky ones are formed by different oxidation states of iron in the crystal lattices of the rock or due to impregnations of some transition elements during the rock formation. The sugary ones have granular textures and are friable when struck with hammer.The ferruginous types are rich in iron.They are very common in Okemesi and itawure.The quartzites have varying textures from equigranular, medium grained to coarse-grained. The varieties of quartzites are closely related that, often, it is impossible to indicate them as separate units on the map. The quartzites consist of mainly quartz which is usually more than 70% with minor amounts of interlocking grains of biotite and orthoclase. Structurally, the quartzites are jointed, with some having joint sets around Ayikunnugba (Oke-Ila) area, while others are foliated. Dips ranging between 40^0W-66^0 W were measured around Soso and OkoAjindo areas. In some areas for instance, they have very high dips ranging from 66^0 E to almost horizontal at Okemesi, most especially along the limbs and fold closure. The quartzites in the area have orange-yellow colour due to mineral impurities.Quartz vein is the dominant structural feature on the rocks in this locality.

Biotite-Gneisses

This is a foliated, medium to coarse-grained, dark to almost black coloured rock composed chiefly of biotite and little quartz. It occupies the north central area and extends towards the north western part of the study area. A band of biotite gneiss concordantly lies within the quartzites around Ajindo area. The rock has been severely weathered and covered with sand thereby making field observation difficult to carry out. The varieties seen at Ikoro and Ijero are the highly foliated type with bands of black tints imposed by biotite impregnations alongside felsic minerals such as quartz and plagioclase feldspar. Most of the mineral alignments are conformable with the foliation planes of the adjacent schistose rock.

Granite-gneiss.

The granite gneisses are common in Okemesi and Epe. They exhibit mineralogical banding of felsic and mafic minerals. The felsic minerals are the quartz and feldspar (plagioclase) and mafic minerals are biotite. The texture is medium to coarse grained.

Biotite-schists

The biotiteschists encountered in the study area occurs around ArapateErigbe and Soso area of EkitiState as a lenticular body within the quartzites and migmatite gneiss, and it is exposed due to stream activity as low lying outcrop. It has undergone various levels of deformation. Structurally, foliation is present thereby making the name “biotite schist” appended to the rock as confirmed by petrographic studies. Other structural features on the rock include microfolds and joints which control the stream flow. Field observations showed that this rock dips at 48^0 W to the surrounding rocks. The rock is medium grained and contains quartz and biotite which is the dominant mineral, and it is dark grey in colour. The rock also occurs in Ikoro and Ijero area as a schistose rock with grayish colour, and with black patches of biotite, It exhibits fine grained texture. It covers nearly two-thirds of Ijero area with pegmatite intrusions along Ijero-Ikoro road. It is also found in Arapate/Soso area with structures such as foliations and micofolds.it contains quartz and biotite.

Quartz-BiotiteSchists

This group of rock occurs in lowland areas between quartzite and banded gneiss around Oko-Esinkin2 area (eastern part of Okemesi) where it has been exposed by stream channel and road cut. The rock has been highly deformed with the adjacent migmatite-gneiss- quartzite complex, the foliations on the outcrop is defined by biotite streaks. The rock has medium to coarse grained texture and consist mainly of biotite, quartz, plagioclase feldspar and orthoclase feldspar. Structures found on the outcrop are fractures, and the rock is grey to dark in colour.

Pegmatites

This lithologic unit ranges from a few meters in length and is located in the southeastern part of Okemesi where it intrudes the banded gneiss around Aba Francis and Ikoro area as an isolated hill. Texturally, it is extremely coarse-grained with quartz, feldspar and muscovite as distinguished mineral component. Quartz vein, joints and veinlets are the structures observed on the outcrop. Based on field observation, the pegmatite is the complex type with distinct textural and mineralogical variations with an impure white colouration. It is the youngest rock in Ikoro area, unlike the Okemesi pegmatite which is the simple type due to uniform variation of its constituent minerals. Pegmatite intrusions also occur towards the south-western part very close to the centre of Ijero town, which is also complex. It extended to the quarry site in Ijero along Ijero-Ipoti road. The pegmatite in Ijero area is zoned, consisting of massive quartz at the core, and followed by mica schists with smoky quartz impregnated with tourmaline and purplish quartzite. In Ara and Epe area of Ijero, the pegmatites here intruded into the biotite schist and migmatite gneiss that occupies the central part of the area, covering about three-quarter of the total land mass. The pegmatites in this area are very coarse grained igneous type with phenocrysts over 250mm in length, usually of granitic composition. The pegmatite in Ipoti and OdoOwa areas are associated with cassiterite-tantalite mineralization (Fadipe, 1988). They are found associated with migmatite gneiss and amphibolites with very coarse grained texture and consists of feldspar, tourmaline and garnet while pegmatites in Ijero is enriched with unusual trace elements which thus result in the crystallization of unsual rare minerals such as beryl, tourmaline, columbite and tantalite. The pegmatites in Ijero occur as a low but large elongate hill of average height of about 50m above sea level. Some of the pegmatites in Ijero have been and are still being worked on most especially at Ijero and other villages such as Ikoro, Odo-Owa, Saloro and OkeAsa. The dominant minerals are orthoclase, albite, quartz, microcline and biotite.

Calc-gneiss

This is a typical gneissic rock with abundance of calcium. It exhibits a characteristic black colour with white fragments of quartz. The texture of the rock is mostly fine grained. Joints are the major structures discovered on the outcrop, and are common in most parts of Ikoro. Part of the lithological unit is exposed at Odoagba (Ikoro) where the stream takes it course. They are medium to coarse grained.It is also common in Ijero where it is composed chiefly of calcite and quartz. It occurs mainly as nodules and discontinuous streaks up to four inches in thickness. It is also made up of a mosaic of twinned grains of calcite enclosing isolated rounded crystals or composite spots of silicate minerals.

Granites

Varieties of granites based on mineral composition, texture and grain sizes are very prominent in the south eastern part of the study area most especially in Ofale, Osun/ Epe, Iroko, and Idao parts of the study area and form well defined boundaries with the quartzites. Their textures range from fine, medium to coarse grained. They occur as hilly, low lying, flat and extensive outcrops in most area with sparse vegetations. Structures common the outcrops include quartz vein, veinlets, pegmatite dykes which trend north-south, exfoliation, folds of different styles, xenoliths etc. A typical granitic rock must have > 60% of quartz to be termed an acid igneous rock. However, the granites occur as pockets of rocks within the biotite gneiss in Ikoro and Ijero area. They have colour variations ranging from specks of whitish, grayish to ash colour and patches of dark colour indicating ferromagnesian minerals.

Mica schists

The mica schists extend across most part of Ipoti, OdoOwa and Ijero, but occur prominently around Ipoti and Ijero. They are highly susceptible to weathering and erosion thereby reducing the quantity of fresh samples. In these areas, quartz-muscovite and quartz-muscovite-biotite schist are exposed in many places and have been highly pegmatized.

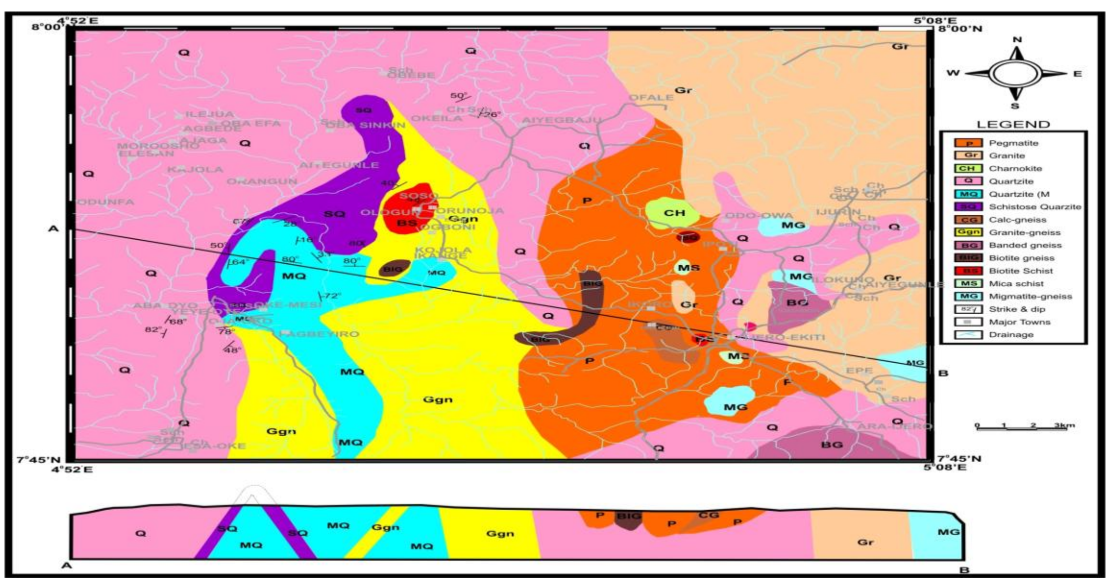
Migmatite-gneiss complex

This is presumably the oldest group of rocks and the most wide spread of all the lithologies, occupying 30% of the total surface area of Ijero and its surroundings. Its concordant lithostratigraphic relationship with the juxtaposed quartzite at Ayegunle gives credence to its probable metasedimentary origin. It is a mixed rock with a characteristic nature of a typical metamorphic rock which has taken an igneous character through partial melting. The migmatite has a mineralogical composition of quartz, orthoclase feldspar, hornblende and mica.. It is not widely distributed in AraEpe area unlike the pegmatites, but occupies the northern part. It is characterized mostly by alternating light and dark bands of minerals. In Ipoti, OdoOwa area, the rock has been weathered in-situ to give rise to high quality clays of economic importance, whereas, it occurred as a fresh low-lying outcrop in Ijero. It also possesses schlieren texture which is an example of granite formation in migmatites. This is typical of the samples picked from Epe. Migmatites in Epe are characterized by ptygmatic folds and are believed to exhibit ductile deformation of the gneissic banding. Structures like folds and microfaults were also seen on the outcrop. The strike value of the rock is 340^0 and dip is 32^0W.

Charnockites

The charnockites occur as an intrusive body north of OdoOwa within the massive quartzites and the gneisses as a coarse grained variety of charnockites which are foliated. They vary in texture and petrography and range from banded types to fine and medium grained. Though, the coarse grained varieties are common around Ipoti and Odoowa area. They also occur as discrete and individual bodies within the migmatite-gneiss-quartzite complex. Mineralogically, it consists of hornblende, biotite with little or no quartz. Structures seen on the rock are solution holes, quartz veins. The various rock units mapped in the course of field work were compiled to produce a geologic and cross-section map of the study area (Fig.2)

Fig. 2: Geological map of the study area



Method of Study

The methods adopted for this research work is divided into two aspects namely field and laboratory operations. The field operation is essentially geologic mapping of the study area to determine the underlying lithologic units. The geologic mapping was carried out at a scale of 1:50,000 using grid-controlled sampling method at a sampling density of one sample per $4sqkm^2$ for the collection of stream sediments and rock samples (Figs 3&4). Thirty-five (35) rock and stream sediment samples were obtained. The rock samples were collected from different localities in the studied area, after which they were labeled accordingly to avoid mix up. The location of each outcrop was determined with the aid of a Global Positioning Systems (GPS) and the lithologic and field description of each samples were correctly recorded in the field notebook. The samples were bagged and transported to Petroc Laboratory, No.2, Shasa Road, Ibadan, where it was pulverized and crushed using standard procedures and were later digested using the total digestion method. 40g of the digested samples were packaged into containers provided and properly labeled, and were sent to ACME Laboratories, East Vancouver, Canada for geochemical analysis to determine the major oxides using atomic absorption spectroscopy (AES) while the trace and rare earth elements were determined using inductively coupled mass spectrometry (ICP-MS). Sediment samples were taken at a depth of 20-25cm; they were bagged and labeled to avoid mix up before transportation to the laboratory. The geographical locations of each sample collected were noted and recorded in the field notebook. Also the characteristic features of the stream sediments collected were also recorded in the field notebook as well. The laboratory operations involve pulverization and homogenizing the stream sediment samples using a pulverizer to allow to crush the coarse particles in the sediments after which the milling machine was used for further pulverization until the samples became very fine in size (-15µm). 40g of the homogenized sample was analyzed by inductively coupled plasma mass spectrometry (ICP-MS). Samples were dissolved using Lithium Tetraborate fusion method followed by HCl and HF acid digestion (Watts and Johnson, 2010). This digestion method was chosen to provide a more aggressive dissolution of refractory minerals than a standard mixed-acid method. The sediment samples were placed in a sample container which was properly labeled and were transferred to ACME Laboratories, East Vancouver, Canada for major elements determination using AES and the trace and rare earth elements using inductively coupled plasma-mass spectrometry(ICP-MS).

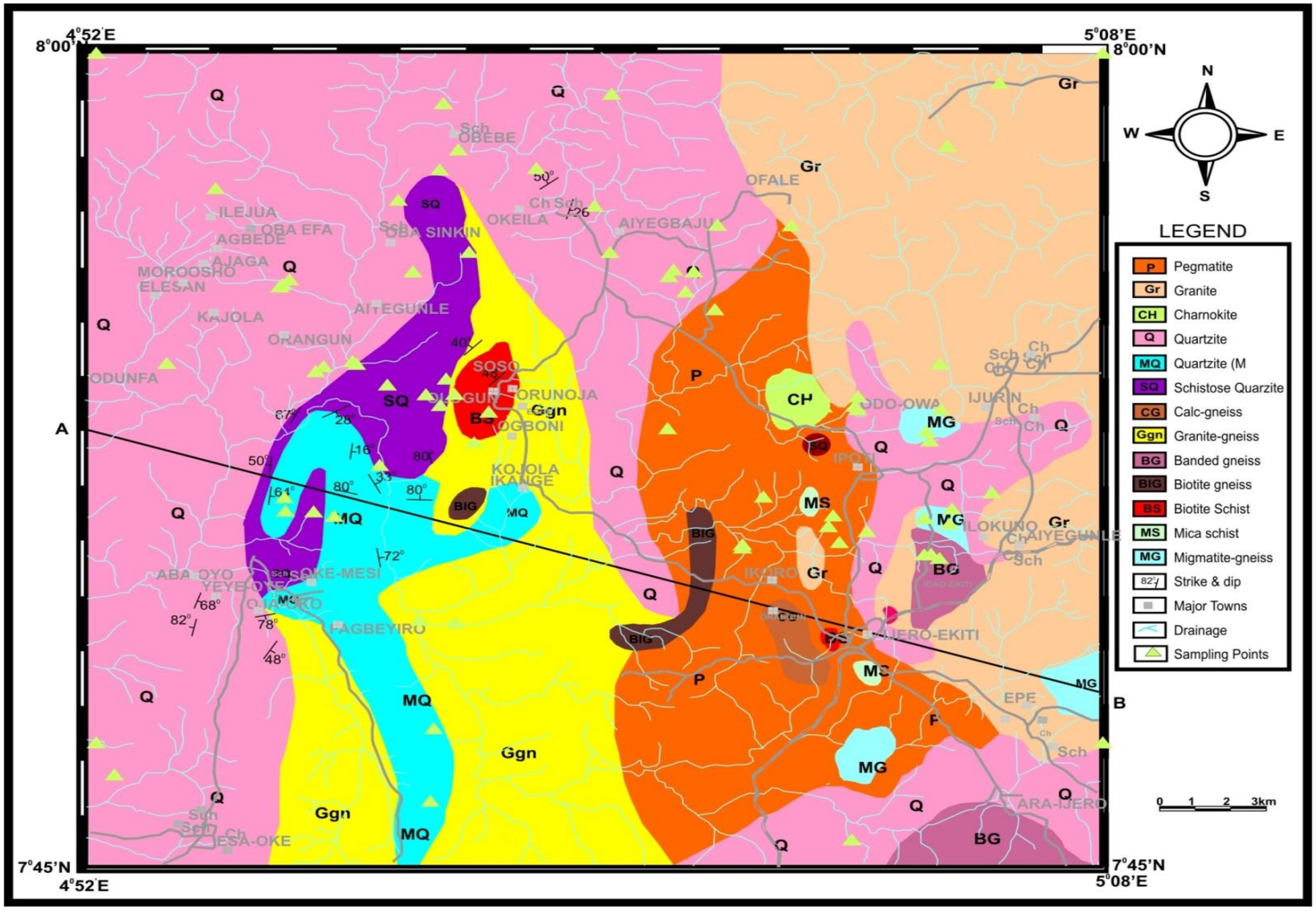


Fig. 3: Rock sampling points

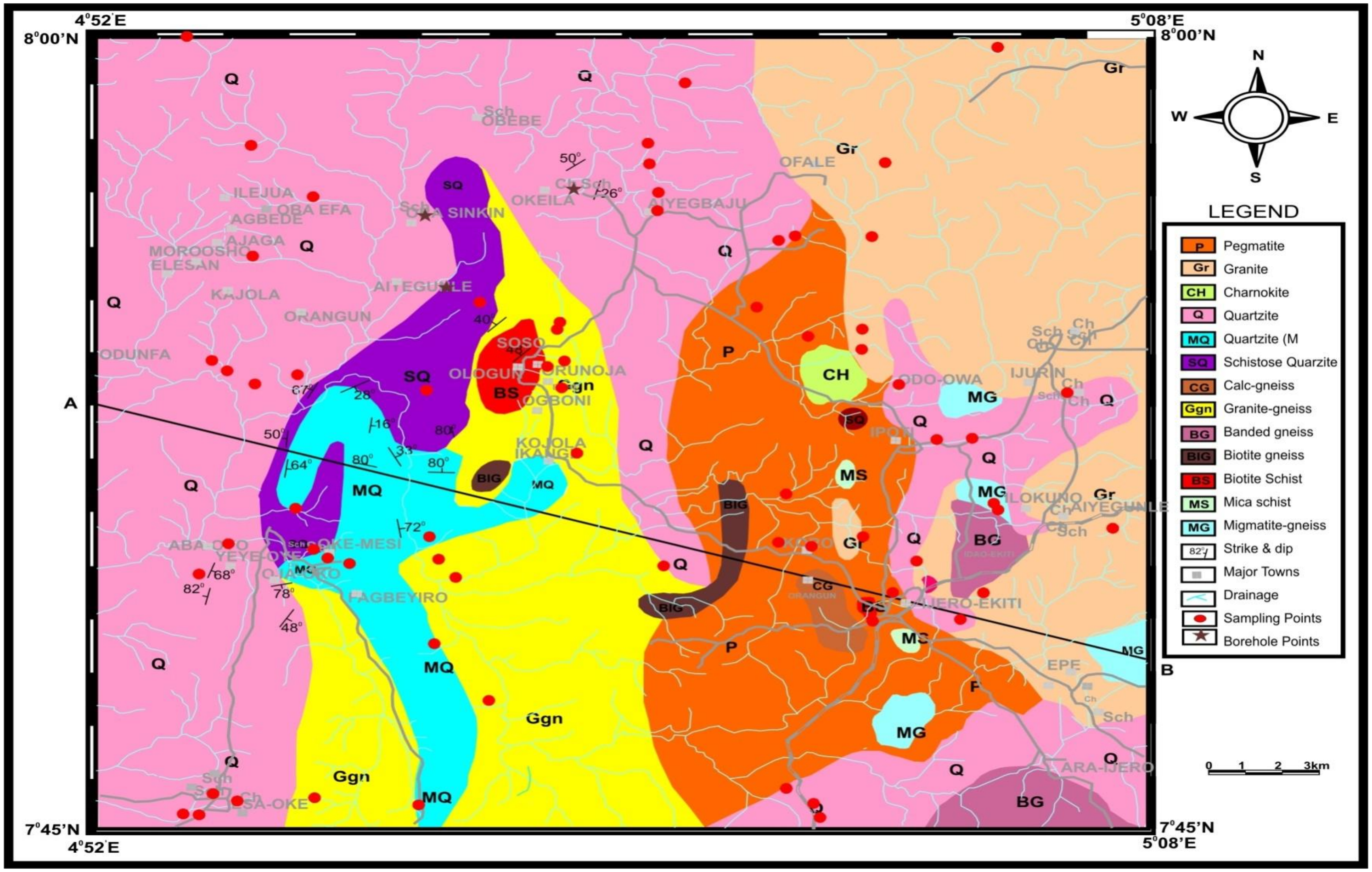


Fig. 4: Stream sediment sampling points

Table 1: Weathering indices of the crustal rock samples collected from the study area (%)

Sample ID	TiO_2	Al_2O_3	MgO	CaO	Na_2O	K_2O	WIP	PIA	CIW	CIA
Aba Francis	0.002	0.003	0.033	0.028	0.003	0.024	0.285	-215.37	9.315	5.439
Arapate	0.007	0.013	0.033	0.294	2.813	5.218	58.274	248.10	0.404	0.151
Baba Orioke 8b	0.642	1.213	1.625	1.875	3.010	3.567	50.218	-92.99	19.894	12.552
Idao 2	0.354	0.668	1.525	2.043	3.760	4.736	63.981	-234.52	10.324	5.961
Ido Ile 3A	0.452	0.854	2.222	3.050	3.188	3.567	53.577	-76.96	12.041	8.011
Ido Ile 3	0.048	0.091	0.033	0.098	0.127	0.422	4.275	312.46	28.915	12.385
Ijero Lepidiorite	0.048	0.091	0.033	0.056	0.078	0.458	4.227	157.73	40.518	13.370
Ijero pegmatite	0.017	0.032	0.066	0.112	0.170	1.928	16.628	117.45	10.058	1.406
Ijero 5A	0.003	0.006	0.033	0.490	7.007	2.012	56.875	-36.54	0.084	0.066
Ijero 5B	0.003	0.006	0.000	0.000	0.046	0.024	0.000	-63.49	12.088	8.266
Iloko L1	0.018	0.035	0.000	0.000	0.061	0.133	0.000	262.93	36.361	15.210
Ilokun 4	0.003	0.006	0.000	0.000	0.028	0.096	0.000	145.81	18.208	4.810
Ilokun 4C	0.025	0.047	0.00	0.00	0.078	0.301	0.000	144.47	37.676	11.076
Ikoro6	0.522	0.986	1.227	2.896	3.288	3.675	53.690	-76.95	13.755	9.094
Iroko Ekiti	0.025	0.047	0.000	0.070	0.039	0.157	0.000	31686.23	30.238	15.102
Iroko2	0.082	0.154	0.199	1.329	2.626	4.230	50.961	3390.19	3.757	1.851
Odo owa1	0.450	0.851	0.763	2.700	4.161	3.049	52.873	-47.13	11.031	7.906
Oke-Ila Granite	0.517	0.977	1.194	3.344	3.559	3.748	56.419	-67.06	12.397	8.401
Oke-Ila 1	0.377	0.712	0.713	1.399	2.600	4.061	50.136	-514.77	15.114	8.118
Oke-Ila 8	0.095	0.180	0.166	0.546	3.068	4.422	53.874	674.42	4.735	2.186
Okemesi Rd	0.053	0.101	0.149	0.588	2.209	5.230	55.468	219.94	3.479	1.241
Okemesi Li	0.552	1.043	0.912	2.966	3.305	4.121	57.106	-96.40	14.259	9.120
Okemesi 2 ferrug	0.020	0.038	0.033	0.042	0.031	0.181	1.720	204.30	34.130	12.969
Okemesi-3	0.077	0.145	0.000	0.000	0.066	0.458	0.000	126.75	0.000	0.000
Okemesi 5	0.332	0.627	0.216	0.000	0.030	1.964	0.000	102.27	0.000	0.000
Okemesi 6	0.013	0.025	0.00	0.000	0.000	0.036	0.000	100.00	0.000	0.000
Okemesi L9	0.277	0.523	0.978	0.588	1.291	4.868	48.251	176.19	21.775	7.194
Okemesi L14	0.195	0.369	0.862	0.294	0.648	5.013	45.185	125.45	28.123	5.830
Okemesi L15	0.203	0.384	0.829	0.294	0.915	4.579	43.203	140.50	24.123	6.228
Okemesi L19	0.150	0.284	1.011	0.797	1.717	3.940	43.599	320.21	10.134	4.208
Osun Epe Ekiti	0.050	0.095	0.033	0.028	0.043	0.615	5.240	115.84	57.066	12.116
Itawure 20A	0.364	0.687	0.514	2.266	5.094	4.157	66.176	-89.21	8.536	5.628
Itawure 20B	0.012	0.022	0.00	0.00	0.026	0.024	0.000	-8.67	0.000	0.000
Itawure 2C	0.077	0.145	0.00	0.00	0.067	0.169	0.000	-54.45	0.000	0.000
Soso	0.053	0.101	0.050	0.098	0.059	0.506	4.583	163.40	39.070	13.194
Itawure 20A	0.012	0.022	0.000	0.000	0.026	0.024	0.000	-8.67	0.000	0.000
Itawure 20A		0.000	0.000	0.000	0.020	0.000	0.000	0.000	0.000	0.000

Table 2: Weathering indices of stream sediments taken from the study area (%)

Sample ID	Al_2O_3	MgO	CaO	Na_2O	K_2O	WIP	PIA	CIW	CIA
Agbagabara	4.042	0.066	0.252	0.062	0.289	3.101	92.284	92.796	87.019
Baba Iyabo	2.645	0.265	0.238	0.101	0.759	7.285	84.763	88.640	70.661
Baba Orioke 8b	10.578	0.199	0.350	1.004	5.085	47.140	80.226	88.653	62.162
Baba Orioke 8c	12.411	0.398	0.700	2.049	4.627	50.167	73.904	81.869	62.724
Ede 1	16.661	0.812	0.266	0.670	4.157	38.369	93.037	94.682	76.588
Ede 2	13.242	0.298	0.308	0.522	3.037	28.045	92.483	94.105	77.402
Effon 1	4.647	0.050	0.070	0.034	0.181	1.794	97.732	97.818	94.233
Effon -Okemesi 3c	2.607	0.050	0.028	0.023	0.181	1.672	97.945	98.085	91.839
Effon -Okemesi 3	1.341	0.000	0.042	0.105	0.458	4.324	85.723	90.115	68.913
Effon -Okemesi 2	0.756	0.000	0.000	0.036	0.193	1.750	93.926	95.405	76.727
Esa oke 2	3.967	0.050	0.028	0.028	0.386	3.342	98.453	98.601	89.977
Esa oke 3	1.379	0.000	0.042	0.038	0.096	1.047	94.149	94.535	88.675
Esa oke 6	8.406	0.116	0.140	0.253	1.615	14.695	94.526	95.530	80.718
Esa oke 14	2.512	0.216	0.168	0.108	0.759	7.169	86.411	90.111	70.826
Esa oke 17	3.721	0.149	0.238	0.286	1.398	13.321	81.609	87.665	65.949
Ido Ile 2	2.985	0.050	0.084	0.042	0.193	1.956	95.691	95.958	90.357
Ikoro- Okemesi	6.819	0.298	0.462	0.526	3.145	29.156	78.819	87.352	62.267
Ijero Ipoti river	17.681	0.116	0.224	5.596	1.012	40.521	74.123	75.237	72.130
Ilokun1	7.556	0.249	0.518	0.690	3.699	34.554	76.151	86.218	60.627
Iroko 16	5.856	0.415	0.546	0.786	1.747	19.709	75.525	81.475	65.542
Kajola 16	1.473	0.182	0.168	0.069	0.627	5.848	78.160	86.162	63.057
Odo owa Abidogun	13.299	0.862	0.126	0.124	2.049	18.234	97.827	98.155	85.264
Ofale Rd	11.995	0.182	0.308	0.216	1.964	17.588	95.040	95.819	82.824
Okemesi-2	0.793	0.000	0.000	0.022	0.217	1.858	96.394	97.353	76.889
Okemesi-3	1.115	0.000	0.000	0.027	0.157	1.407	97.262	97.638	85.856
Okemesi-4	1.096	0.000	0.000	0.026	0.349	2.942	96.681	97.716	74.497
Okemesi-6	2.267	0.066	0.084	0.117	0.578	5.491	89.351	91.847	74.409
Okemesi-9	1.096	0.000	0.000	0.013	0.121	1.041	98.636	98.785	89.104
Omi osa	2.342	0.000	0.056	0.151	0.856	7.787	87.782	91.883	68.795
River Akola	1.322	0.000	0.000	0.035	0.494	4.153	95.940	97.418	71.422
River Elewu	5.327	0.033	0.196	0.807	3.025	29.127	69.649	84.151	56.944
River Eri	6.083	0.249	0.196	0.443	2.109	19.960	86.141	90.489	68.880
River Isa 7c	7.065	0.033	0.126	0.481	4.651	40.177	79.901	92.086	57.329
River Oyi	3.362	0.083	0.126	0.194	1.217	11.118	87.019	91.310	68.628
Oke-Ila 1	5.459	0.133	0.252	0.429	2.085	19.634	83.219	88.917	66.379

Geological field mapping

Ten distinct lithological units were recognized in the studied area which were compiled to produce a geological map (Fig.2) which are the schistose and the massive quartzites occurring as quartzite ridge (EffonPsammite Formation) which runs norh-south, granites occurring as plutons and intrusions, calc-gneiss as intrusions within the migmatite and the quartzite while the schists and migmatites occurred as distinct rock groups. The schists, quartzites and migmatites are interbanded. Other lithologies include the gneisses, pegmatites and charnockites occupying different portions of the study area with well-defined boundaries. The major structure in the area is an antiform which is visible on the schistose quartzites in the studied area.

Weathering Profile of the crustal rocks

Table.1 represents the weathering indices of the crustal rocks from the study area.The weathering index assessment of the rocks was carried out to ascertain whether the rock samples collected from the various locations in the studied area are fresh or weathered. This is to justify the reliability of the geochemical analytical results of the rocks. The weathering indices employed is WIP, PIA, CIW and CIA respectfully. The CIA values range from 0.006% -15.10% which indicates that the crustal rocks collected from the study area are largely unweathered (fresh rocks).The CIW and PIA values show a positive correlation with CIA. The WIP shows a negative trend, indicating that the higher value of WIP is a reflection of rocks that are largely fresh samples. Therefore, the rock samples used for this study are fresh samples which give a good result for the interpretation of the nature and the geological processes in the study area.

Weathering Profile of sediments in the source area

The weathering profile of the sediments is presented in Table 2. Weathering indices are useful tools to illustrate weathering profiles and ascertain the degree of weathering of the sediments and minerals incorporated in them. Some minerals are accumulated as deposits due to the process weathering and transportation. Most heavy minerals forming placer or paleo-placer deposits are products of weathering from the parent rock. Therefore, it is necessary to ascertain the level and extent of weathering of the sediments to ascertain their usefulness in mineral genesis and exploration. The weathering indices used in this study to examine the decomposition of unstable minerals are (I). Chemical index of Alteration (CIA) Nebbit& Young (1982) (ii).Weathering index of Parker (WIP) (iii) Plagioclase index of Alteration (PIA)

(iv) Chemical index of weathering (CIW) Harnois (1988).The chemical index of alteration (CIA) is defined as CIA=100*Al_2O_3/(Al_2O_3)+CaO +Na_2O+ K_2O,Chemical index of weathering (CIW) =Al_2O_3/CaO + Na_2O, Weathering Index of Parker (WIP) = 2Na_2O/0.35 + MgO/0.90 + 2K_2O/0.25 +CaO/0.70 and Plagioclase index of Alteration (PIA) = 100*(Al_2O_3 –K_2O)/Al_2O_3 + Na_2O + CaO –K_2O).In the formular given above CaO* is the amount of calcium oxide in corporated in the silicate fraction of the studied stream sediment smples. Corrections for CaO from carbonate contribution were not done for the studied samples since there was no CO_2 data. Accordingly, to compute for CaO* from the silicate fraction, the assumption proposed by Burke *et al*, (1988) was adopted. In this regard, CaO values were accepted only if CaO is less than equal to Na_2O.For the CIA, the low CIA of approximately 50% implies an unweathered upper crust or weak weathering, but high CIA value such as 76% - 100% indicates intense weathering with a complete removal of alkali and alkaline earth elements and an increase in alumina according to McLennan (1993), Fido *et al*, (1995) and Dupuis *et al*, (2006). The weathering profile of the stream sediment showed that the least of CIA in the stream sediments collected from the study area ranges from 56.94% -94.23% (Table.2). The weakly weathered stream sediments were collected at these two locations namely River Elewu and Issa 7C area.

From Table 2, stream sediment samples from Effon 1 and Okemesi 3C were intensely weathered with CIA values of 91.84% and 94.23% respectively, including the samples from Agbagbara, Ede 1, Ede 2, Effon 1, Effon-Okemesi 3C, Effon-Okemesi 2, Esa-Oke 2, Esa-Oke 3, Esa-Oke 6, Ido-Ile 2, Odo-owaAbidogun, Ofale Rd, Okemesi2&3 and lastly Okemesi9. These are intensely weathered stream sediments. They do not contain stable minerals grains according to their CIA values. The extent of weathering at the source area can also be determined by Plagioclase index of alteration (PIA). The plagioclase index of alteration shows corresponding values with CIA (Table.2). The high PIA value indicates intense weathering of the plagioclase feldspars from the parent materials. The chemical index of weathering (CIW) shows a positive correlation with the CIA and PIA. This showed that all the listed locations above that have intense weathering are also revealed by chemical index of weathering in Table 2. The weathering index of Parker (WIP) showed a negative correlation with CIA, PIA and CIW, indicating that the low values of WIP is a reflection of intense weathering of the sediments in the source area.

Conclusion

Detailed geological mapping has provided an insight into the nature and disposition of the different rock units in the area. The geology of the study area from field examination confirmed the earlier assertion of Hubbard (1975), who described the geology of the area as being characterized by a thrusted interface, known as Ifewara fault which separated the Ilesha schist belt into two groups of contrasting lithologies. The geological mapping revealed the dispositions of the various rock units in the area such as the migmatites which are the oldest rocks in the study area upon which other rocks such as granites, calc gneisses and mica-schists intruded. The massive and schistose quartzites, although of the same rock units do not exist together in the area, they are interbanded with the gneisses and migmatites or occur as distinct rock units with massive topography.. The strike values of the quartzites (schistose and massive) range from 024^0-046^0in some places. Also, the rocks dip in the western direction, with values such as 40^0W - 80^0W in some areas of study,while other areas it dips in the eastern direction with dip values ranging between 72^0E - 80^0E respectively. The high dip values could be attributed to several episodes of deformation that characterize the rocks in the area which is manifested in the brittle nature of the quartzites that display several joints and fracture sets which also control the drainage pattern in the area.The weathering index analysis of the rocks also confirmed that the rock samples used for this research are fresh using the weathering indices parameters while some sediment samples collected for geochemical analysis also ranges from weakly weathered to intensely weathered which may not be totally suitable for mineral exploration purposes.

Recommendation

Detailed geochemical exploration for gold and other precious metals is desirable in the study area because of its geologic and thermo-tectonic setting.

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