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Primary study of weathering and different formations of rocks outcrops in the Zigui region, western Hubei province (China).

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ABSTRACT: This paper describes the formation of the Zigui region; the geological processes play an important activity in the area. The stratigraphic developed well in the area and the characteristic components passed the jointing positions are not different from each other in certain geological ages, suggesting that the characteristic components in the areas are probably primary at the same time during geological processes.
The composition of rocks varies according to its minerals, which are the building blocks of rocks. The types of minerals that make a rock depend largely on the source of the rock - igneous rocks have more magma-related minerals like olivine and biotite; sedimentary rocks have more sediment-related minerals like quartz; metamorphic rocks have all these minerals, but they may look different due to re-crystallization.
Considering the location, landscape, and present system of slopes, could have been covered by deposition of sediment from running water, wind, or lakes? The sediment transported in from some other area, but simply covered in their weathered debris. Weathering is a rapid process capable of producing a regolith in only a few hundred years in a temperate climate. The products of weathering are spheroidal boulders, decomposed rock fragments, and soil.
KEYWORDS: Zigui, Weathering, outcrops

I. INTRODUCTION

Zigui County is a county of western Hubei Province. It is under the administration of Yichang City and encompasses the easternmost portion of the Yangtze River Gorges, including the Xiling Gorge. The county seat of Zigui is now the town of Maoping (Maoping Zhen) situated a few kilometers west of the Three Gorges Dam on the high southern shore of the river. The original Zigui town was upstream to the west and was abandoned and submerged under the rising waters of the reservoir in the early years of the 21st century. As it is common in China, Maoping is typically labeled as "Zigui County" (Fig. 2-1).

Most of Zigui is hilly or mountainous with basic farming and tea production. There are many small coal mines in the mountains, with the coal trucked to the river then loaded onto barges for shipping downstream. Zigui is also called Stone Town or Gourd Town, because in ancient times their walls were of huge stone stabs and the city itself looked like a gourd. The walled city features with traditional Chinese style architecture.

Fragrant Stream is a small stream just below Zigui and above the entrance to Xiling Gorge. The county located at the foot of Woniu Mountains and the north side of the Yangtze River. It is a world cultural celebrity Qu Yuan's hometown, the birthplace of dragon boat racing.

II. LOCALISATION OF THE AREAS AND REGIONAL GEOLOGICAL SETTING

2.1 The study area

The study area is located at the Zigui segment of The Yangtze Three Gorges (Fig. 2-2), which is known as one of the most landslide-prone areas in the Three Gorges Reservoir region, lying between the latitudes 30.837° N and 31.06° N and the longitudes 110.566° E and 110.875° E, and covering an area of 405.54 km^2. There are five towns: Xietan, Shazhenxi, Guizhou, Guojianba and Quyuan. The area is separated from N to S by The Yangtze River with a declining topography from SW to NE.

The Yangtze Three Gorges area was formed by a severe incision of massive lower Paleozoic and Mesozoic (Jialinjiang Group of Triassic system) limestone mountains, along narrow fault zones, in response to the Quaternary uplift. Steep slope angles develop on outcrops of easily weathering or ‘‘soft’’ materials, which are extended, and landslides are common in these areas (Bai et al., 2010).

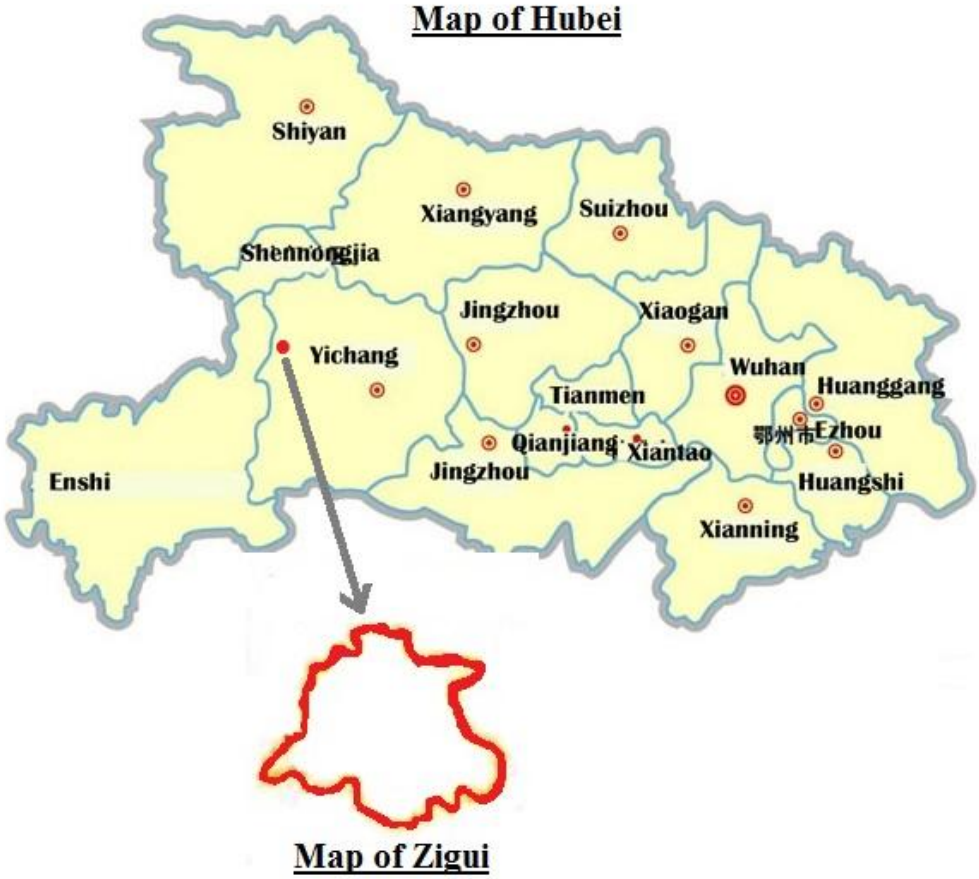


Fig. 2-1: Location of study area

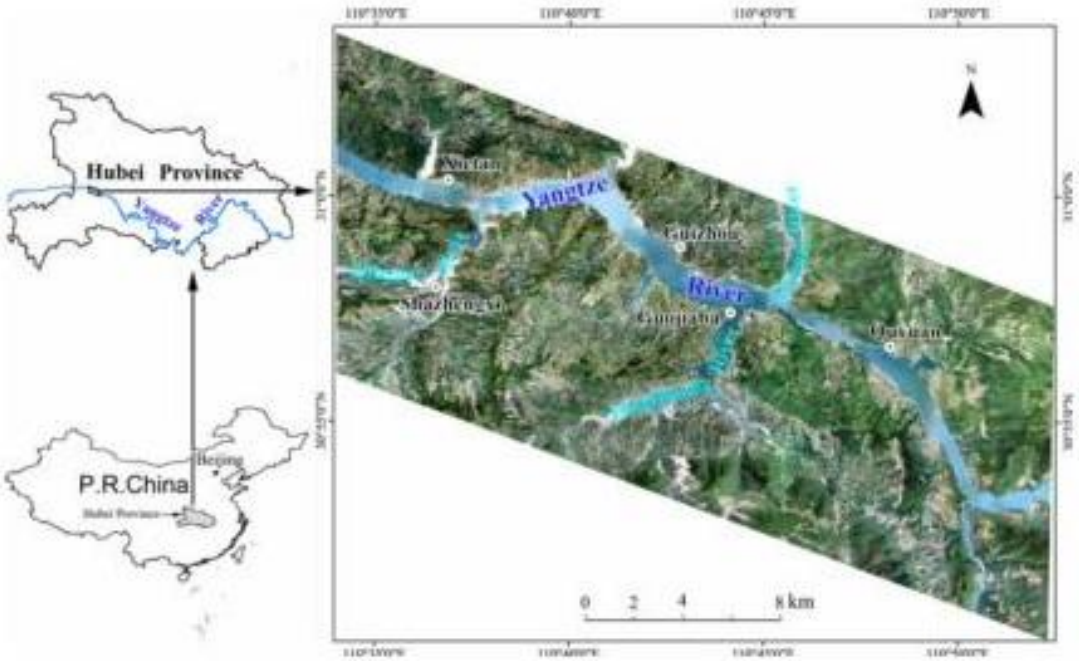
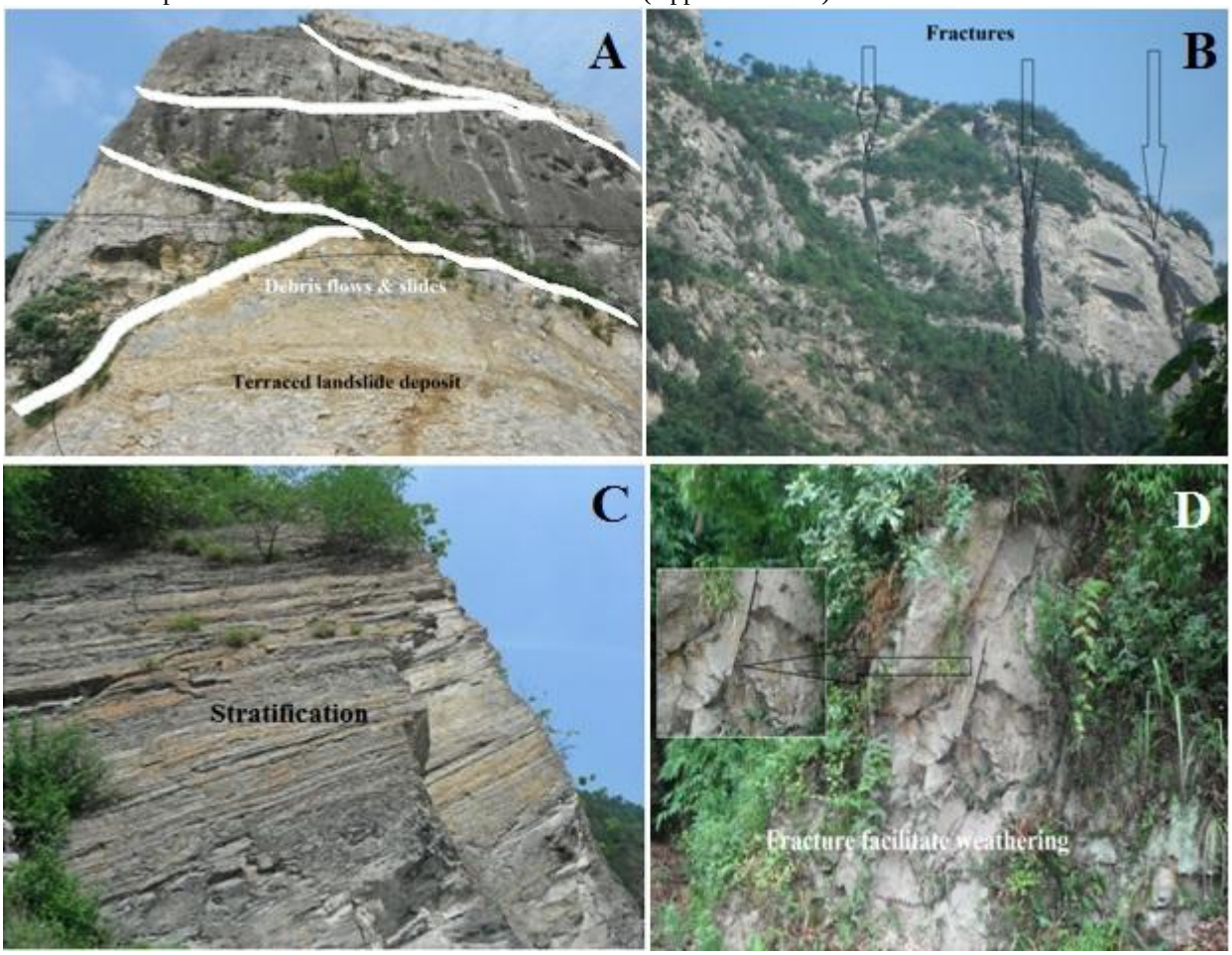


Fig. 2-2: The study area and its location

2.2 Strata

A layer of material, naturally or artificially formed, often one of a number of parallel layers one upon another. In this area, mainly hosted mineral deposit, comprised dolomite with mud, limestone, shale and slate. Some mineral spots can also be observed in Cambrian strata (Appendix 2-1 C).



Appendix 2-1: Stratification and fracture facility weathering

2.3 Structures

The Xingshan-Zigui section (110.38"E, 3 1 .15"N) is a continuous section located along the Xiangxi River valley in Xingshan and Zigui counties in Hubei Province, near the northern bank of the Yangtze Gorges, geologically situated at the northern margin of Yangtze Block. The valley cuts through the eastern part of a great Paleozoic and Mesozoic geosynclinorium that folded at the Cretaceous (Fig. 2-3). the oldest rock exposed to this region is the Banxi Formation, with an about 800 Ma

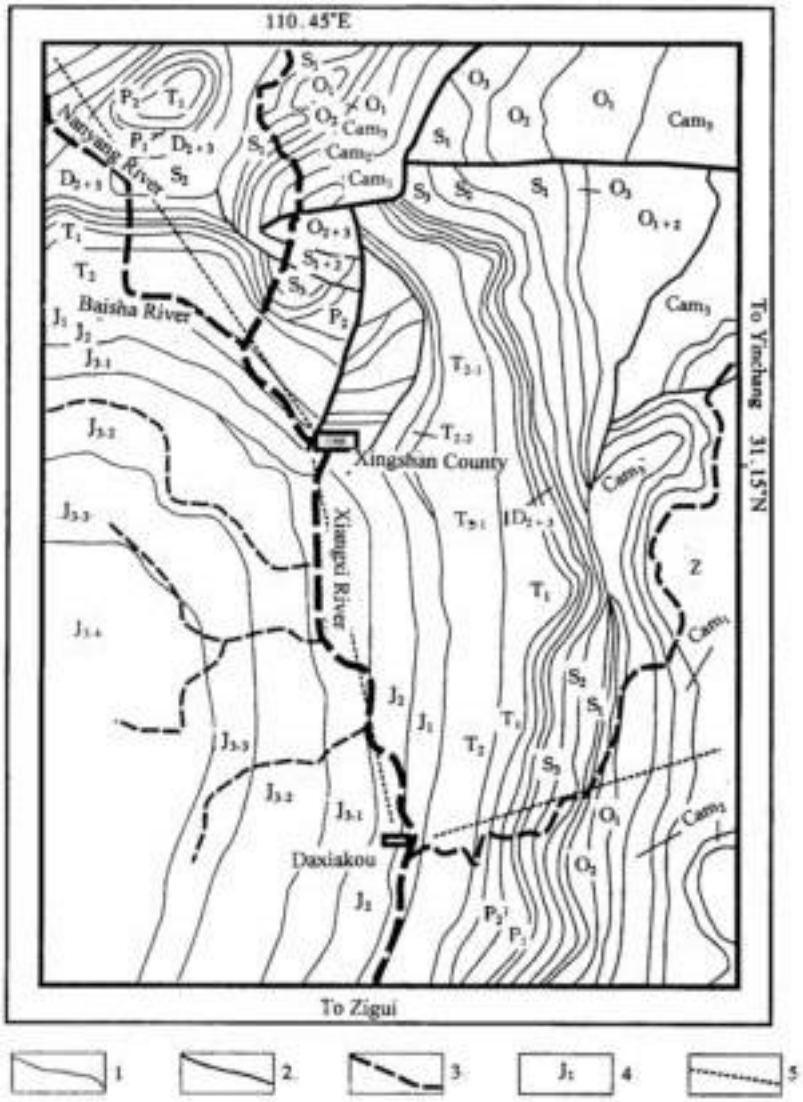


Fig. 2-3: Schematic map of sampling, XS-X~Ngshan City. 1, Geological boundary; 2, fault; 3, river; 4, geological time; 5, sampling section.

metamorphic age, which was the basement of the Late Proterozoic to the Jurassic sedimentary basin. The Paleozoic and Mesozoic sedimentary rocks were almost continually formed in this grand basin. We said "almost continually where because of the sedimentary hiatus of the Early to Middle Devonian and Carboniferous in this basin, the most widely recognized regional parallel unconformities in the stratigraphic sequence of the Yangtze Block. Omitting that, all the Paleozoic and Mesozoic sediments were continually deposited there. From the Cambrian to Early Triassic the sediments were deposited in an epicontinental to the shelf shallow sea. The Cambrian is argillaceous-carbon- ate facies (dark gray mudstone, marl and limestone). The Ordovician to Devonian are carbonate and argillaceous-clastic deposits (limestone, marl, mudstone and siltstone, all with dark colors). The Permian and Lower and Middle Triassic are carbonate facies (dark gray limestone). From the Upper Triassic the epicontinental marine basin had changed into a great inland drainage basin in which the Upper Triassic gray sandstone, Jurassic varicolored sandstone and red beds were formed. There is not any sort of volcanic rocks discovered there. Fossil control for the sedimentary sequence is excellent. The ages of the sediments have been well determined based on biostratigraphic methods by the Chinese geologists since geology mapping in the 1960s. 825 oriented paleomagnetic samples distributed at 84 sites, covering the time during Cambrian to Jurassic were collected by using a carriageable drill (WU Hanning et al., 1998).

The Yangtze Three Gorges area of China has attracted attention around the world because of the Three Gorges Dam and its potentially strong impact on the environment. Historically the Three Gorges area was always been characterized by a high landslide disaster. More than 2,500 known localities with unstable slope angle exist in this area (Bai et al. 2010).

2.4 Formations of the study area

Our identifications in the Zigui region focused on the three types of rocks, there are the basic foundation of Geology as a science: Igneous rocks, sedimentary rocks and metamorphic rocks.

2.4.1 Igneous rock

Igneous rock is formed through the cooling and solidification of magma or lava. Igneous rock may form with or without crystallization, either below the surface as intrusive (plutonic) rocks or on the surface as extrusive (volcanic) rocks.

Mineral composition: Feldspars, quartz or feldspathoids, olivines, pyroxenes, amphiboles, and micas are all important minerals in the formation of almost all igneous rocks, and they are basic to the classification of these rocks. All other minerals present are regarded as nonessential in almost all igneous rocks and are called *accessory minerals*. Types of igneous rocks with other essential minerals are very rare, and these rare rocks include those with essential carbonates (Appendix 3-6).

2.4.2 Sedimentary rock

Sedimentary rocks are formed from sediments. Sediments are small pieces of material which do not dissolve in water. They slowly fall down to the bottom of a lake or the sea, and gather together over the years forming a large mass of material.

Imagine stirring very fine sand into a glass of water. Slowly the sand particles settle on the bottom of the glass.

They are called "sediments" from the Latin sedimentum meaning "a settling". Materials which do dissolve (salts) stay in the water. This is what has made the sea salty over many millions of years.

2.4.3 Metamorphic rock

Metamorphic rocks are rocks that have undergone a change from their due to changes in temperature, pressure or chemical alteration. The classification of metamorphic rocks based on the minerals that are present and the temperature and pressure at which these minerals form determination of this information is not easily accomplished.

The mineralogical and structural adjustment of solid rocks to physical and chemical conditions that have been imposed at depth below the near surface zones of weathering and digenesis and which differ from conditions under which the rocks in question originated.

III. REGIONAL GEOLOGICAL SETTING OF MINERAL RESOURCES

3.1 Weathering

Weathering is the breakdown and alteration of rocks at Earth's surface through physical and chemical reactions with the atmosphere and the hydrosphere. We noted different types and nature of weathering:

- Physical weathering is the mechanical fragmentation of rocks from stress acting on them. Ice wedging may be the most important type.
- Chemical weathering involves chemical reactions with minerals that progressively decompose the solid rock. The major types of chemical weathering are dissolution, acid hydrolysis, and oxidation.
- Joints and fractures facilitate weathering because they permit water and gases in the atmosphere to attack a rock body at considerable depth. They also greatly increase the surface area on which chemical reactions can occur.
- The major products of weathering are spheroidal rock forms, a blanket of regolith, and dissolved ions. Soil is the upper part of the regolith—a mixture of clay minerals, weathered rock particles, and organic matter.
- Climate and rock type greatly influence the type and rate of weathering.

Physical weathering is the breakdown of rock into small fragments by physical processes without a change in chemical composition. No chemical elements are added to, or subtracted from, the rock. The most important types of physical weathering are ice wedging and sheeting, or unloading.

Other Types of Physical Weathering: Animals and plants play a variety of relatively minor roles in physical weathering. Burrowing animals, such as rodents, mechanically mix the soil and loose rock particles, a process that facilitates further breakdown by chemical means. Pressure from growing roots widens cracks and contributes to the rock breakdown. Lichens can live on the surface of bare rock and extract nutrients from its minerals by ion exchange; the presence of lichens, therefore, results in both physical and chemical alteration of the minerals. These processes may seem trivial, but the work of innumerable plants and animals over a long period of time adds significantly to the disintegration of the rock.

Chemical weathering is the breakdown of minerals by chemical reactions with the atmosphere or hydrosphere. The three main types of chemical reactions are (1) dissolution, (2) hydrolysis, and (3) oxidation. During chemical weathering, rocks are decomposed, the internal structure of the minerals is destroyed, and new

minerals are created. Thus, there is a significant change in the chemical composition and physical appearance of the rock.

Dissolution is a process whereby a mineral passes completely into solution, like salt dissolving in water. Some minerals dissolve directly in water and the ions are leached, or flushed away. Halite (salt) is perhaps the best-known example. The most common dissolution reactions involve slightly acidic water. Carbonic acid H_2CO_3 is common in natural environments and forms when water combines with carbon dioxides. This reaction takes place in the atmosphere and in the root zones of plants where carbon dioxide is released into the soil.

Hydrolysis is a chemical reaction wherein water and another substance both decompose into ions; the OH^- ion groups with one of the fragments and the H^+ ion with another fragment.

Oxidation is the chemical combination of oxygen, in the atmosphere or dissolved in water, with one mineral to form a completely different mineral in which at least one of the elements has a higher oxidation state (higher ionic charge). Of the elements that have variable charges, iron is the most important in weathering reactions on Earth.

The weathering of rocks is influenced by a number of variables, such as the mineral composition, the texture of the rock, and the climate in which weathering occurs. Differential weathering is a result of differences in the rates of weathering. Weathering is influenced by so many factors that it is difficult to make a meaningful generalization concerning the weathering of specific rock types. Limestone, for example, may weather and erode into a soil-covered valley in a humid climate, whereas the same formation forms a cliff in an arid climate. Similarly, a well-cemented quartz sandstone may be extremely resistant to weathering, whereas a sandstone with a high clay content is likely to be soft and weak and weather rapidly.

Products of weathering: The major products of weathering are (1) rock bodies modified into spherical shapes; (2) a blanket of loose, decayed rock debris, known as regolith, of which soil is an important part; and (3) ions in solution.

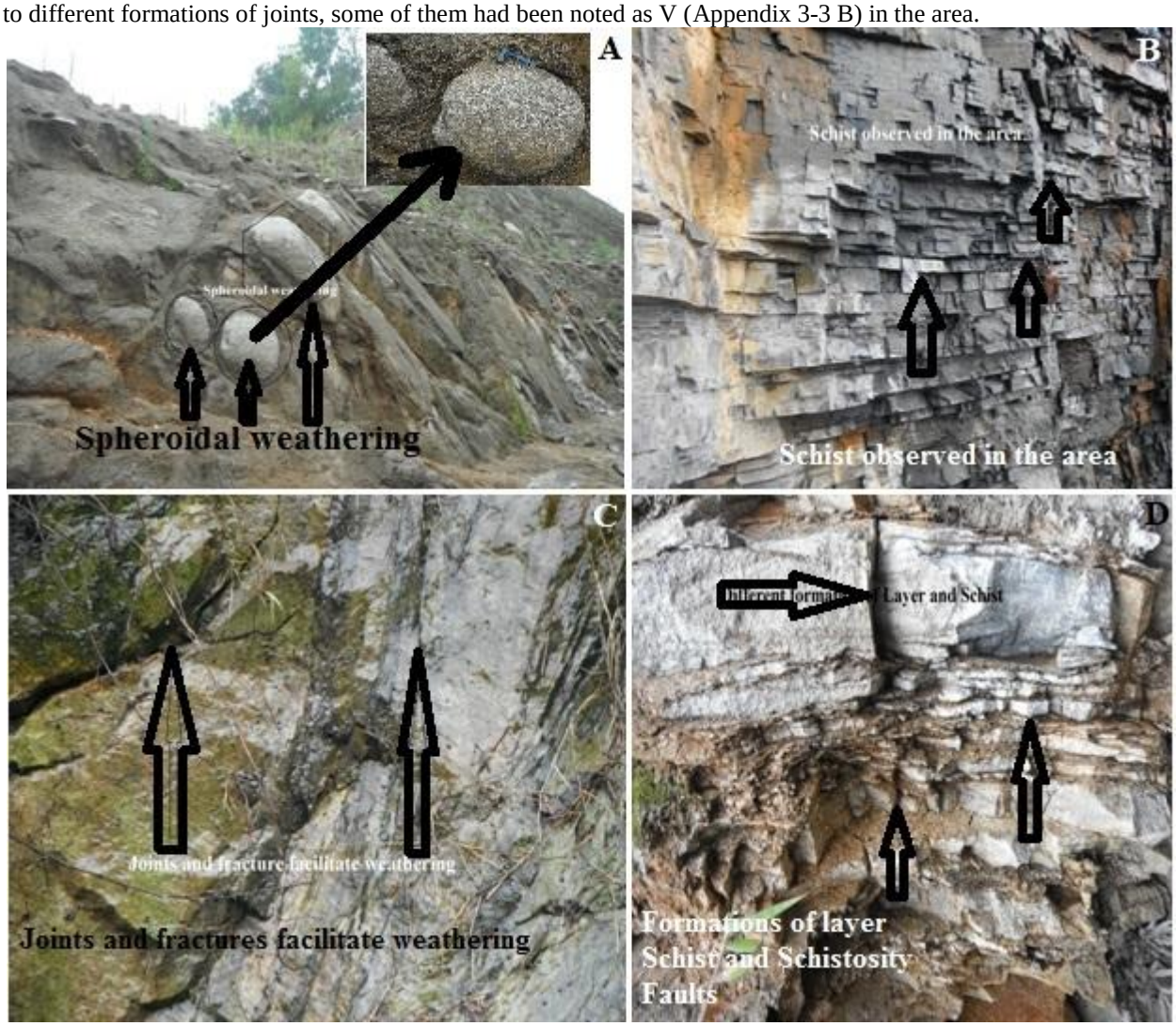
Appendix 3-1: Sandstone bedding and slope instability

3.1.1 Spheroidal weathering

In the weathering process, there is a universal tendency for rounded (or spherical) surfaces to form on a decaying rock body regardless of the original shapes of the rock fragments. The sphere is the geometric form that has the least amount of surface area per unit of volume. A rounded shape is produced because weathering attacks an exposed rock from all sides at once, and decomposition is most rapid along the corners and edges of the rock (Fig. 3-1(A, B, C). Appendix 3-2 A). As the decomposed material falls off, the corners become rounded, and the block eventually is reduced to an ellipsoid or a sphere. Once the block attains this shape, it simply becomes smaller with further weathering. This process is known as spheroidal weathering.

Examples of spheroidal weathering can be seen in almost any exposure of rock (Appendix 3-2 A (3-4)). It can also be seen in the rounded blocks of ancient buildings and monuments. The original blocks had sharp corners and were fitted together with precision. The edges are now completely decomposed, and each block has assumed an ellipsoidal or spherical shape. In nature, spheroidal weathering is produced both at the surface and at some depth.

In the study area we had observed the formation of Schist and Schistosity (Appendix 3-2 A, D). According to different formations of joints, some of them had been noted as V (Appendix 3-3 B) in the area.



Appendix 3-2: Spheroidal weathering. Schist and schistosity in the areas

Granite starts out in the subsurface already fractured by "joints". The pattern of fracturing splits granite into blocks that are cube-like in shape. This happens when the joint fractures come into contact with water that seeps into the cracks. This all takes place meters beneath the surface, where chemical decay weathers the minerals into granite sand. Corners of the cube have three joints that intersect, so the corners decay the most. Decay on the corners gives the boulder a "spheroidal" shape. Erosion of the decayed granite (Grus) exposes these boulders at the surface. Spheroidally-weathered boulders are "born rounded" by subsurface mineral decay (subsurface weathering).

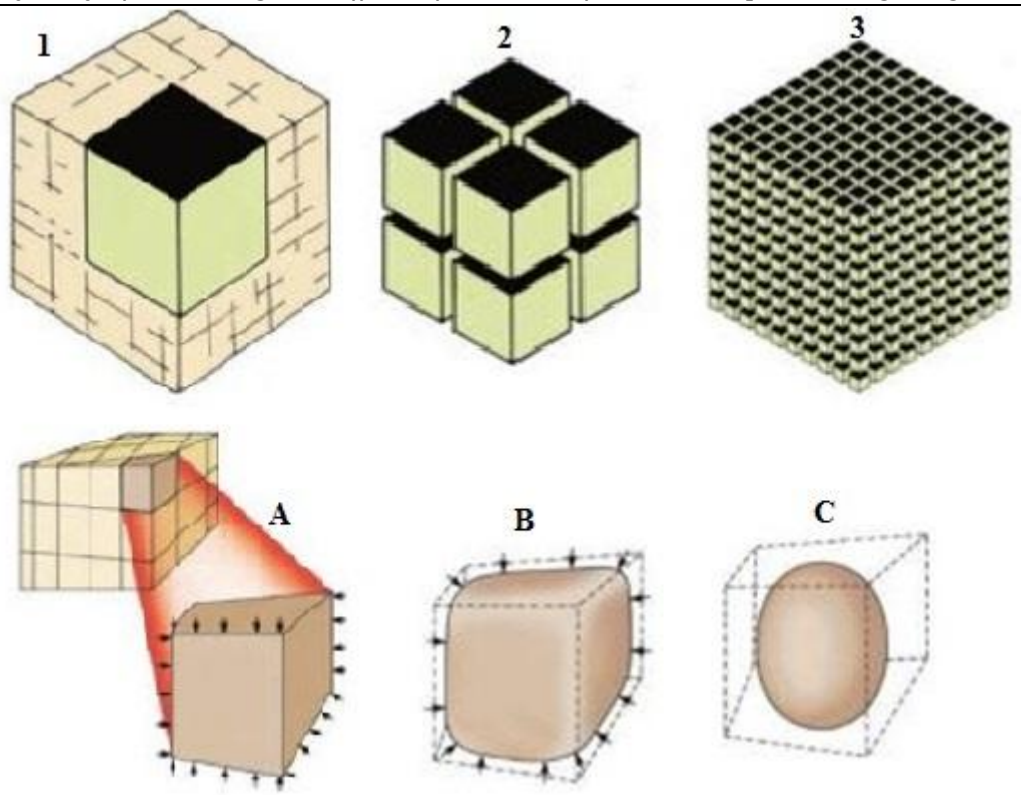


Fig. 3-1: A set of joints systems cut a rock body into angular blocks

3.2 Structure

The regional geology of the Three Gorges consists of apre-Sinian crystalline basement, composed of magmatic and metamorphic rocks, and a Sinian–Jurassic sedimentary cover, comprising interbedded carbonate, sandstone and shale formations (Wu et al. 2001).

The lithological formations of Wushan–Zigui can be classified according to their competence into (1) massive limestones and dolomites, (2) sandstone–shale–marl interbeddings, and (3) mudstone, slope deposits, and Quaternary sand and gravel. Limestones tend to form steep slopes and ridges, and, where traversed by tectonic faults and lineaments, can be heavily jointed and sheared. Sandstones, shales, and marls form complex interbeddings where lithologies of contrasting physical properties, such as shear strength and permeability, are frequently juxtaposed. Mudstones are usually weathered, and often comprise loose bedrock fragments within a matrix of finer material, such as sand and clay. Quaternary deposits tend to accumulate on gentle or moderately steep slopes, or along river banks where they form easily eroded terraces (I.G. Fourniadis & J.G. Liu 2007).

The main structure of the Three Gorges area contains developing faults , including the Hubei tectonic belt in the northwest, the Hubei fold belt to the southwest and the central Hubei block. The earthquakes in this area are mainly distributed in the Hubei tectonic belt and the central Hubei block. The Hubei tectonic belt trends NWW, which corresponds to the E-W -trending that crosses the core of the Huangling anticline and reveals its deep structure (Wang Jian et al., 2012).

April 1, 2014. A magnitude-4.7 earthquake hit Zigui County in central China's Hubei Province last Sunday, around 23 kilometers from the Three Gorges Dam site location, several days after a magnitude -4.3 tremor was felt early Thursday morning about 30 kilometers from the dam.

May 28, 2014. Another earthquake has struck the Three Gorges Dam reservoir region in central China's Zigui County. No casualties have been reported so far and the dam is operating normally. The 3.4 magnitude tremor which hit early Monday morning, some 23 km from the dam, follows two earthquakes of magnitude above 4.0 and hundreds of aftershocks which shook the same region in late March of this year.

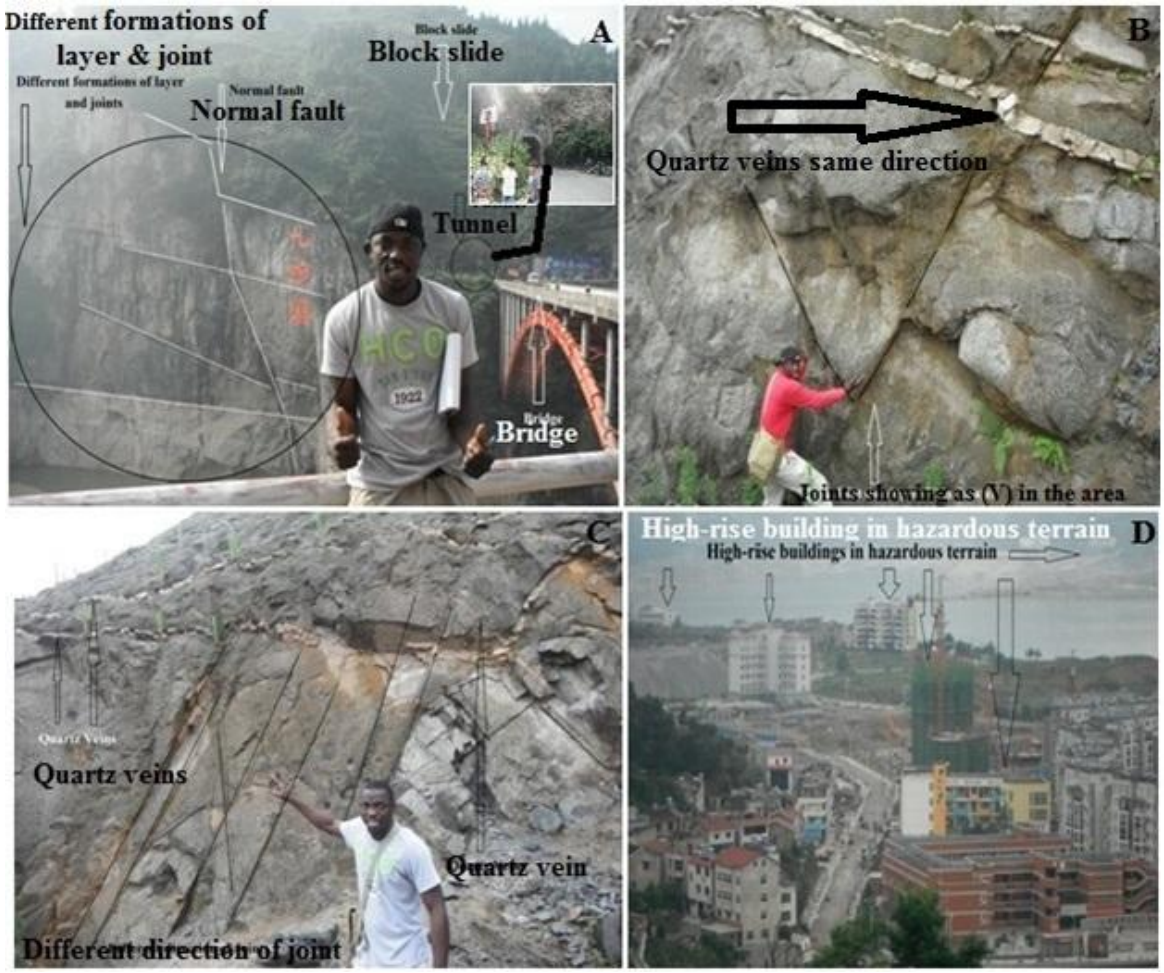
The upper Neoproterozoic section of Sandouping Town (Jiulongwan-Toudingshi), Zigui County, Hubei Province shows the most intact and completes sequence of the Nantuo and Doushantuo Formation (TANG Feng 2005).

3.2.1 Fault

In geology, a fracture in the rocks of the Earth's crust, where compressional or tensional forces develops, causes the rocks on the opposite sides of the fracture to be displaced relative to each other. Faults range in length from a few inches to hundreds of miles, and displacement may also range from less than an inch to hundreds of

miles along the fracture surface (the fault plane). Most, if not all, earthquakes are caused by rapid movement along faults. Faults are common throughout the world.

However the region of Zigui developed joints are in the same direction through quartz veins because they occur at the same time and under the same geological processes (Appendix 3-3 B. Appendix 3-4).



Appendix 3-3: Fault and quartz veins showing in the area

We noted that in the area, the jointing is commonly the major type of structural weakness in granite and related rocks and causes the rock to break up into large blocks. Spheroidal weathering then rounds the edges of the fragments (Appendix 3-4). Granular disintegration in granite is common, producing crumbly spheroidal boulders. The disintegrated material consists of feldspars weathered to clay and quartz grains. The dissolution of calcite cement in a sandstone also causes granular breakdown. See also (Appendix 3-4 A).

Exfoliation is a special type of spheroidal weathering in which the rock breaks apart by separation along a series of concentric shells or layers that look like cabbage leaves. The layers, essentially parallel to each other and to the surface, develop by both chemical and physical means. Exfoliation may involve sheeting in rocks such as granite; if they are brought to the surface after deep burial, they have a tendency to expand upward and outward as the overlying rock is removed.

Appendix 3-4: Fault and quartz veins showing in the area

3.2.2 Fold

Fold is used in geology when one or a stack of originally flat and planar surfaces, such as sedimentary strata, are bent or curved as a result of permanent deformation. Many folds are directly related to faults, associate with their propagation, displacement and the accommodation of strains between neighboring faults.

The elevation of the ore body occurrence is strongly controlled by structures, and the thickness and grade of the ore body increases in the fracture zone. The mineralization is confined to the structural area with the metasediments and crushed quartz veins and calcitization (N. BASSANGANAM 2015).

The region of Zigui, structural orientations of folds is roughly developed; the mainly structural orientations are joints. We noted that the Soil structure in the area is also the most important aspect. The uppermost layer of the regolith is the soil. It is composed chiefly of small particles of rock, new minerals formed by weathering, plus varying amounts of decomposed organic matter. Soil is so widely distributed and so economically important that it has acquired a variety of definitions (Appendix 3-1). The transition from the upper surface of the soil down to fresh bedrock is a soil profile, which shows a rather systematic sequence of layers, or horizons, distinguished by composition, color, and texture.

Several special kinds of soils are worth noting here. The major soil orders are shown in (Appendix 3-1). Some soils are noteworthy because they are ore deposits. For example, aluminum does not migrate far during weathering, and, in fact, it may be concentrated as a residual deposit as other elements are removed.

Topography affects soil development because it influences the amount and rate of erosion and the nature of drainage. Flat, poorly drained lowlands develop a bog-type soil, rich in decomposed vegetation and saturated with water, whereas steep slopes permit rapid removal of regolith and inhibit the accumulation of weathered materials. Well-drained uplands are conducive to thick, well-developed soils (Appendix 3-1). Time is important in soil development in that it takes time for physical and chemical processes to break down the bedrock. In (Appendix 3-1) the young lava flow has a very thin, patchy soil, whereas the older flow has had time for a thick soil layer to develop.

3.3 Alteration of Wall Rock

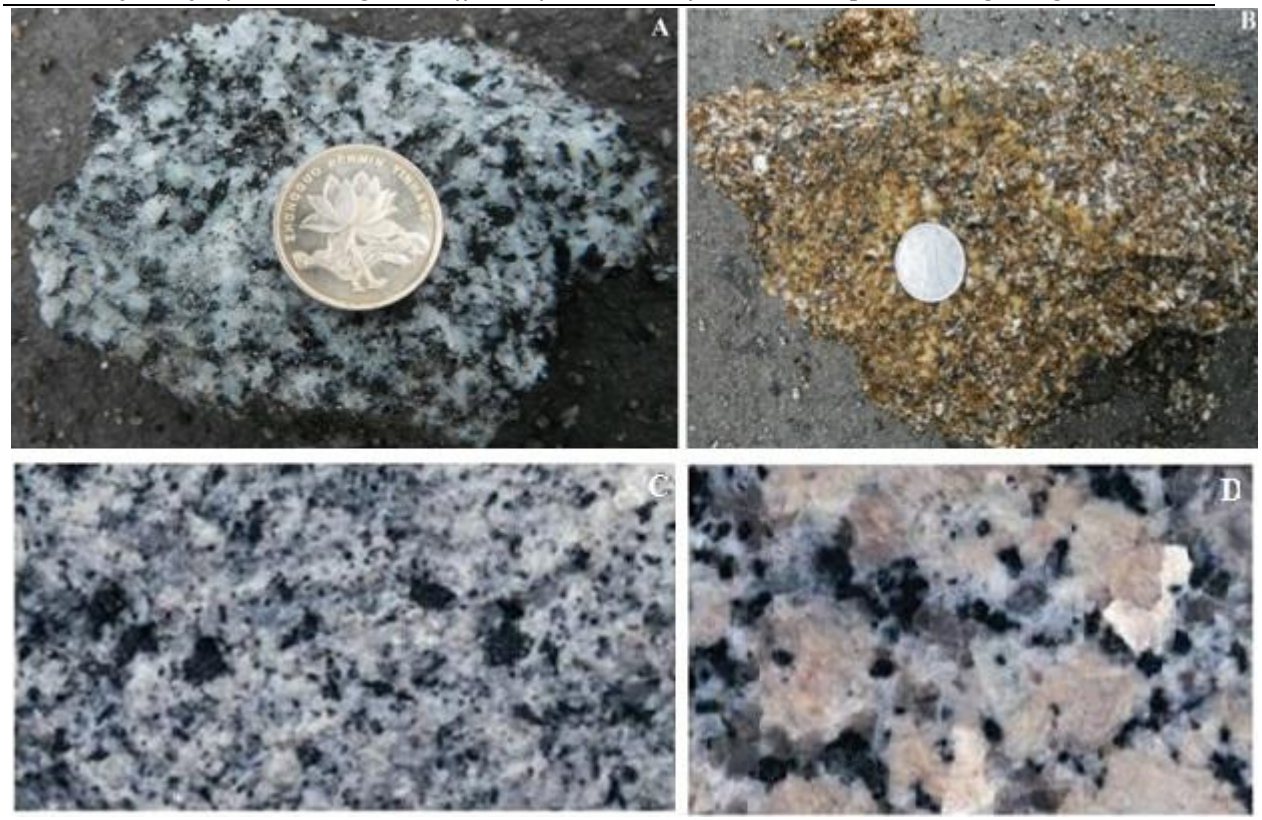
In the area, the degree of weathering decreases from top to bottom. The top layer is heavily weathered while the bottom is nearly un-weathered. From bottom there is the base rock, then half-weathered rock, residual, soil. When a rock is exposed to weathering (physical or chemical) for a long time, it disintegrates into smaller particles which when deposed in the same place are called residual

Appendix 3-5: Changing rock body during wreathing process

3.4 Minerals

Ore minerals occur in open faults, stock works, and breccias and replace adjacent strata resulting in the formation of disseminated ore (Appendix 3-4). In brittle, impermeable, and unreactive rocks, the bulk of the ore is along faults and fractures. In less competent, permeable, and reactive lithologies, ore extends outward from faults to form large tabular bodies.

The increment of fine grade size aggregates is of great significance to absorb Au particles and to form the economic ore bodies.



Appendix 3-6: White and red granite

Granite is a coarse-grained igneous rock composed predominantly of feldspar and quartz (Appendix 3-6 C). K-feldspar is the most abundant mineral, and usually it is easily recognized by its pink color. Plagioclase is present in moderate amounts, usually distinguished by its white color and its porcelain-like appearance. Mica is conspicuous as black or bronze-colored flakes, usually distributed evenly throughout the rock. A very important property of granite is its relatively low density, 3about 2.7 g/cm, in contrast to basalt and related rocks, which have a density of 33.2 g/cm .This fact, is important in considering the nature of continents and the contrast between continental crust and oceanic crust. Granite and related rocks make up the great bulk of the continental crust.

Diorite is similar to granite in texture (Appendix 3-6 D), but it differs in composition. Plagioclase feldspar is the dominant mineral, and quartz and K-feldspar are minor constituents. Amphibole is an important constituent, and some pyroxene may be present. In composition, diorite is intermediate between granite and gabbro. Its extrusive equivalent is andesite.

IV. CONCLUSION

We noticed that in Zigui region, the rocks were igneous rocks mainly composed of three mineral namely: quartz, black mica and feldspar. The rocks were affected by weathering at the same time as such quartz veins, the joint lines are in the same direction; chemical weathering is the most significant form natural influence. Also the multiple stratigraphic occurrences in the area developed under geological processes.

There is high potential impact from landslides in the Wushan–Zigui region of the Three Gorges. Although a large proportion of slope failures seem to occur in the area, and noted that areas are dominated by the mountains that pose little threat to human activities, enough works to combat slope instability have occurred in recent years to justify the need to identify and map landslide distribution and hazard.

Recent studies have shown the feasibility of remote sensing, and of imagery from the ASTER sensor in particular, for the regional assessment of landslide impact (Fourniadis et al. 2007a, b); such regional assessment can form the first step towards identifying those areas in greater need of detailed geotechnical studies with the aim of mitigating the hazard and minimizing the negative impact.

V. Acknowledgements

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REFERENCES

[1]. Bai SB, Wang J, Guo NL, Zhou PG, Hou SS, Xu SN (2010) GIS- based logistic regression for landslide susceptibility mapping of the Zhongxian segment in the Three Gorges area, China. Geomorphology 115:23–31

[2]. WU Hanning ZHU Rixiang, Vincent Courtillot, BAI Lixin, XING Jianxiao, ZHAO Yongxin and YANG Gelian 1998 Paleomagnetic results of Paleozoic and Mesozoic rocks from Xingshan-Zigui section in Hubei Province, South China

[3]. Bai SB, Wang J, Guo NL, Zhou PG, Hou SS, Xu SN (2010) GIS- based logistic regression for landslide susceptibility mapping of the Zhongxian segment in the Three Gorges area, China. Geomorphology 115:23–31

[4]. WU, S.R., SHI, L., WANG, R.J. ET AL. 2001. Zonation of the landslide hazards in the forereservoir region of the Three Gorges Project on the Yangtze River. Engineering Geology, 59, 51–58.

[5]. I.G. Fourniadis & J.G. Liu 2007 Landslides in the Wushan–Zigui region of the Three Gorges, China.

[6]. Wang Jian, Shen Chongyang , Li Hui, Sun Shaoan and Xing Lelin 2012 Gravity inversion of deep-crust and mantle interfaces in the Three Gorges area

[7]. TANG Feng, YIN Chongyu, Bengtson Stefan, LIU Yongqing, WANG Ziqiang, LIU Pengju & GAO Linzhi 2005. A new discovery of macroscopic fossils from the Ediacaran Doushantuo Formation in the Yangtze Gorges area

[8]. BASSANGANAM Narcisse, Associate Prof. Minfang Wang, Yang MeiZhen, Prince E. YEDIDYA DANGUENE. 2015 Study on genesis of the primary orebody in Shewushan gold deposit. *(AJER)* e-ISSN: 2320-0847 p-ISSN: 2320-0936 Volume-4, Issue-7, pp-00