

玄武岩中石英绿帘石型层内错动带成因初探

周志东 苏生瑞

(成都理工学院, 成都, 610059)

摘要 在我国西南地区许多水电站坝区岩体中, 缓倾角的层内错动带发育相当普遍, 它们对岩体的局部稳定性起控制作用。在某玄武岩坝址区, 发育有几种类型的层内错动带, 本文对其中的石英绿帘石型层内错动带的成因进行了初步探讨。

关键词 石英绿帘石 层内错动带 成因

1 概述

不论是层内还是层间错动带, 对水电工程建设都具有重要影响。研究其成因, 弄清楚其空间分布, 对研究岩体结构并评价其稳定性具有重要意义。本文所研究的水电站坝区地层以二迭系峨眉山玄武岩 ($P_{2\beta}$) 为主, 玄武岩内广泛发育了缓倾角的层内错动带 (大多倾角为 $5^\circ \sim 20^\circ$), 是主要的软弱结构面之一, 对坝区局部岩体, 如拱肩槽边坡、进水口边坡、地下洞室等岩体的稳定性起控制作用。根据我们野外对 520 余条层内错动带的调查测绘, 其中石英绿帘石型的层内错动带占有相当大的比例, 可达 30% ~ 40%。据初步研究, 石英绿帘石型的层内错动带胶结好, 可以看成是一种硬性结构面, 其抗剪强度等力学指标明显高于其他软弱夹层, 见表 1。因此, 石英绿帘石的形成使结构面强度发生再生, 石英绿帘石的存在对岩体的稳定性具有有利的一面。然而, 截止目前, 对其成因研究不够, 造成对其空间分布规律的认识不足, 限制了其对工程影响的评价。本文就这一问题作一初步探讨。

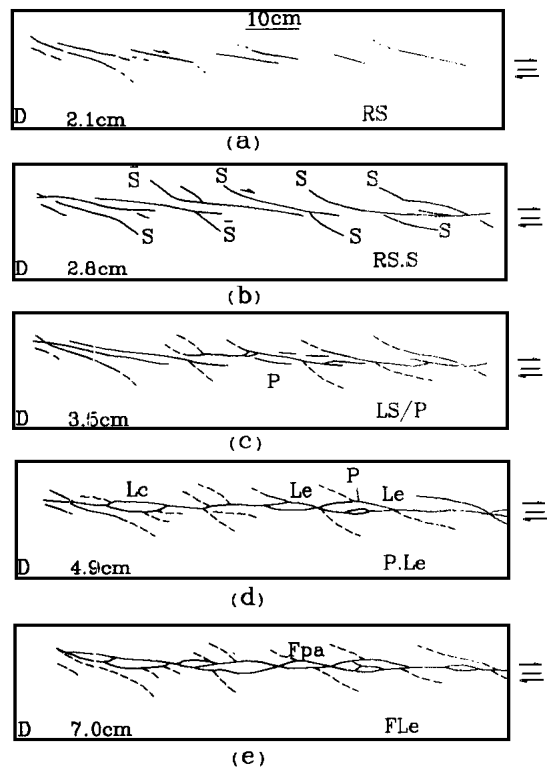
表 1 石英绿帘石型层内错动带
与含屑砾型力学参数比较表

试样编号	类型	σ_n /MPa	长期强度 τ /MPa	C /MPa	ψ /°
	石英	0.615	0.28		
	绿帘石	1.026	0.425	0.062	21.6
PD 7-1	条带型	1.145	0.66		
		2.167	0.83		
PD 26-C ₉	含屑砾型	0.175	0.070		
		0.231	0.084	0.007	20.5
		0.361	0.133		

2 石英绿帘石型层内错动带形成的构造地质背景

在研究区, 玄武岩中层内错动带的形成主要受区域构造应力场的影响而形成。根据其构造形迹的交叉、穿切、限制等关系, 并与区域构造应力场配套, 岩体大致经历了五期构造应力的作用, 见表 2。

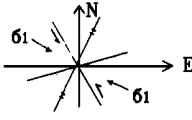
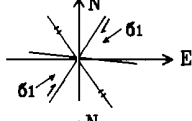
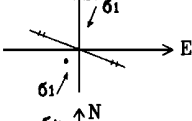
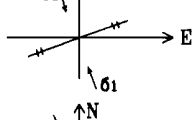
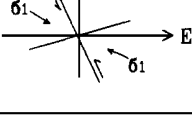
本区层内错动带为典型的吕德尔剪切作用所形成, 它的演化具有三个阶段: 一是层内错动带的初级



D - 位移; RS - 瑞德尔剪切; LS - 低角度剪切; P - 第一世代纯剪切; Le - 第一世代剪切透镜体; FLe - 具有剪切透镜体的贯通性断层; Fa - 活动断层; FLe - 不活动断层; Fpa - 部分活动断层; S - 第一世代剪切破裂带。

图 1 层内错动带演化阶段示意图

表 2 坝区应力场的作用期次及构造演化表

期次	σ_1 方向	构造程式	坝区构造形迹表现
1	NWW		<ol style="list-style-type: none"> 1. 形成 NE 舒缓褶皱及层间错动带; 2. 形成了 NE-NNE 向缓裂; 3. 形成了近 NEE 和 NNW 向陡倾角扭裂面。
2	NEE		<ol style="list-style-type: none"> 1. 形成了左岸的次级迭加褶皱 2. 形成了 NNW-NW 向缓裂, EW、NNE 向陡裂。 3. 形成了左岸 NW 向的层间错动带
3	NNE		<ol style="list-style-type: none"> 1. 形成了 NWW 向缓裂; 2. 形成了 NNW-NW 向陡裂。
4	NNW		<ol style="list-style-type: none"> 1. 形成了 NEE 向缓裂; 2. 形成了 NEE 向陡裂挤压带; 3. 形成了 NW 向陡裂。
5	NWW		<ol style="list-style-type: none"> 1. NNE-NE 向缓裂进一步活动 2. 形成了一些 NNW 及 NEE 向的陡裂

发展阶段,即层内错动带表现为较为简单的平行斜列式组合,层内错动带主要受一期构造应力的影响;二是层内错动带发展的中级阶段,它们表现为平行斜列式层内错动带之间的桥构造发生断裂,或具有分叉现象,形成了波状或分叉式的组合,主错带为砾型或岩块型;三是层内错动带发展的高级阶段,为复合式的层内错动带构成,形成辫状或网状的组合,主错带为含屑砾型或岩屑砾型,它们一般经历了多次构造作用。层内错动带的演化模式如图 1 所示。

根据野外调查和上述分析,石英绿帘石条带型的层内错动带主要形成于层内错动带发展的初级阶段,表现为平行斜列式的简单组合,形成于较早的构造应力场的作用,即一般形成于早期的 NWW 向或 NEE 向构造应力的作用期。同时,根据对坝区随机选取的 24 条石英绿帘石型层内错动带所做的极点图(见图 2)可知,其分布的优势方位为 N 28 E/SE/10 和 N 50 W/NW/11°;进一步证明了其主要形成于最早期的两个构造应力场。当然,石英绿帘石条带在后期构造的作用下亦可能被进一步的改造,使石英绿帘石条带错碎为砾或岩屑。

3 石英及绿帘石成因分析

3.1 形成石英绿帘石的物质来源

研究区的玄武岩为一套间歇性喷溢作用所形成的基性岩浆岩。岩石类型有斑状玄武岩、致密玄武岩、玄武质火山角砾或集块熔岩等,它们的主要矿物

成分为基性的斜长石、辉石、角闪石以及火山玻璃基质等。

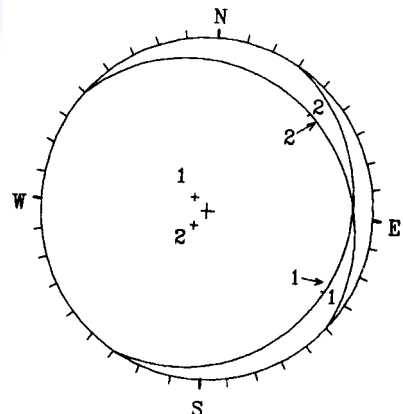
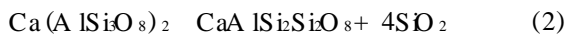
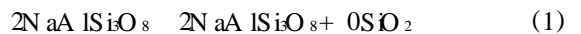


图 2 石英绿帘石层内错动带发育优势方位图

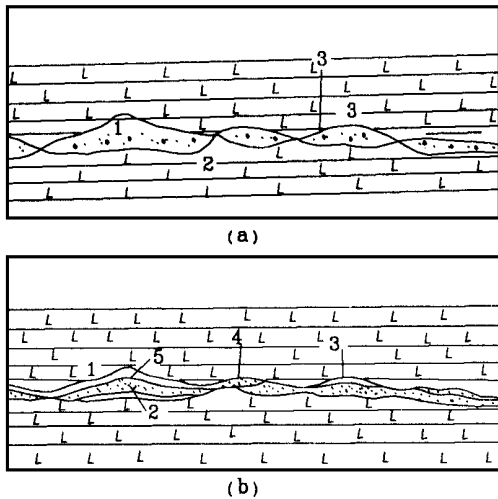
根据国内外许多学者的研究^[1]表明:在构造应力作用下,斜长石越酸性,越不容易析出 SiO_2 , 甚至不析出 SiO_2 , 反之,越基性则越容易析出,析出的量也就越多。它们可以用如下的关系式表示:



上述反应式表明,长石越基性,释放的 SiO_2 也就越多,形成石英的可能性越大。另外,加上钠长石的密度(2.61)小于钙长石的密度(2.67),根据化学反应原理,在压力的作用下,长石趋于释放 SiO_2 而形成更加基性的钙长石,因此,这种基性玄武岩,本身含有大量的基性斜长石,很容易释放 SiO_2 ,在构造应力的作用下,形成石英的可能性也就越大。玄武岩为自身层内错动带内石英的形成提供了物质基

础。

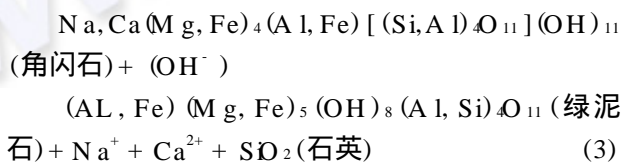
当石英被析出后,在构造应力的作用下,发生“化学挤压”(chemical press),即某些活性组份在不均匀压力的作用下,由压力高处向低压处集中的过程。H. Ramberg K(1952)指出^[1]:差异应力可使活动的元素按 Si, Fe, Mg, Ca, Al, K, Na 的顺序分凝于低压,因而 Si, Fe, Mg 等的氧化物在化学挤压作用下,首先由高压区进入相对较低的层内错动带的扩容带中,见图 3,并在层内错动带中集中形成石英。



(a)初期形成具有剪切扩容空间的夹层;(b)剪切空间消失石英绿帘石条带压密;
1.剪切扩容空间;2.石英绿帘石等充填物;3.岩层;4.压力;5.其他碎屑物。

图 3 石英绿帘石条带在层内错动带的扩容带的形成过程示意图

同时,在构造应力作用下,基性玄武岩中的角闪石、斜长石、辉石等矿物可析出 Ca 离子,并与 Fe、Mg 等离子一起形成绿帘石族矿物,它们的形成是一种后退变质作用产物。如角闪石与流体中的水发生反应形成绿泥石,并析出 SiO_2 ,其反应式如下



由此可知,经过上述物理化学反应过程,石英绿帘石等矿物在层内错动带中形成,并进一步形成石英绿帘石脉。

3.2 石英绿帘石脉形成的温压条件

一般来说,钙长石、角闪石、辉石等析出 SiO_2 、Fe、Mg 等物质必须具备一定的温度压力条件,只有在一定的温度压力条件下,才能发生分解,析出上述物质。

根据前人的实验和总结,在通常情况下,钙长石分解析出 SiO_2 所需压力必须达 1×10^8 Pa,温度为 240。根据我们取样在成都理工学院资源与经济系

包体研究室测定,层内错动带中石英绿帘石条带的石英包体的均一温度为 $80 \sim 160$ (均值为 130),压力为几个兆帕(10^6 Pa),见图 4。因此,可以认为,斜长石、角闪石、辉石等析出 SiO_2 、Fe、Mg 等物质时的温度为 240 以上,压力可达 1×10^8 Pa 以上,但经过化学挤压作用达到层内错动带时,温度与压力已下降,在形成石英绿帘石等矿物时的温度为 $80 \sim 160$ 范围,压力为几个兆帕。

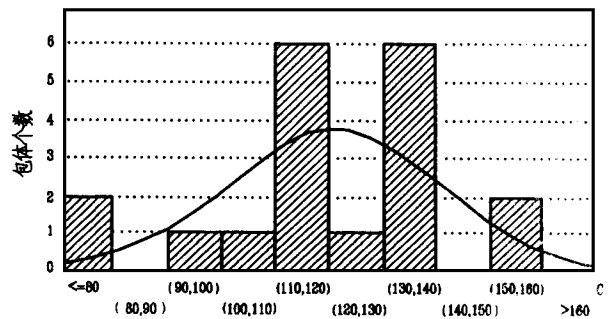


图 4 石英包体测温直方图

4 结 论

根据上述分析我们可以得出如下结论:

(1) 石英绿帘石是在一定的构造地质背景下形成的,一般形成于本区层内错动带演化的初级阶段,主要形成于早期的 NWW 及 NEE 向构造应力场的作用,其分布的优势方位为 $N 28 E / SE / 10$ 和 $N 50 W / NE / 11$ 。

(2) 石英绿帘石是构造热液蚀变作用的产物,主要由基性的斜长石、角闪石、辉石经一定化学变化而成。

(3) 斜长石、角闪石、辉石等析出 SiO_2 、Fe、Mg 等物质时的温度为 240 以上,压力可达 1×10^8 Pa 以上,但经过化学挤压作用达到层内错动带时,存在明显的降温与降压过程,如本文研究的玄武岩中的石英绿帘石等矿物形成时的温度在 $80 \sim 160$ 范围内,压力只有几个兆帕。

参 考 文 献

1. 杨国清 构造地球化学 广西师范大学出版社, 1992
2. 庄培仁、常志忠 断裂构造研究 地震出版社, 1996

作者简介

周志东 男 成都理工学院工程地质研究所 博士研究生
苏生瑞 男 成都理工学院工程地质研究所 副教授 博士

(收稿日期: 1997-12-18)

ABSTRACT

Improvement of the Management And Guarantee of Project Quality

Yang Zongquan

(Sichuan Water Conservancy and Power Research Institute, Chengdu, 610072)

Abstract Construction quality of the Shibanshui Hydropower Station is excellent. According to features of the hydropower station, the Owner takes full responsibility for the project and supervision on project is carried out by Inspector. The construction unit ensures the quality under supervision of the government. Experiences are gained from such a high quality project.

Key words project quality, management system, quality guarantee, supervision

Urgent Development of Sichuan Electric Power Market

Ma Guangwen

(Sichuan University, Chengdu, 610016)

Ai Mingjun

Fan Tianlong

(Sichuan plan committee, Chengdu, 610016)

(Sichuan Electric Power Company, Chengdu, 610061)

Abstract The present Sichuan electric power market is weakening. Electric power supply far exceeds electric power demand, even with negative increase. However, Ertan and Guangan Hydropower Stations will put into operation in succession in 1998 and 1999. Electric Power supply in Sichuan network will increase rapidly. The situation will be severe during a short time. Therefore, it is imperative to analyze and develop Sichuan electric power market and search for new market.

Key words electric power, market, economic

Elementary View on the Necessity for New System "Separation of Power Plant from Electric Network, Connection to the National Network by price Competition"

Ding Ruiqing

(Gongzui General Hydropower Plant, Leshan, Sichuan, 614900)

Abstract After 20-year development of power industry, "Seller's market" turns into "buyer's market". To meet the demand of socialist market economic system, seize the chance and reform thoroughly, a new system of "separation power plant from electric network, connection to the national network by price competition and public dispatching of electricity" should be established so as to gain existence in competition and develop splendidly.

Key words power industry, separation of power plant from electrical network, connection to the national network by price competition, necessity

Nonparametric Disaggregation Model and Its Application in Hydrologic Stochastic Simulation

Wang Wensheng Ding Jing Yuan Peng

(Sichuan University, Chengdu, 610065)

Abstract Disaggregation models are one of the important tools for stochastic simulation of hydrologic series. They can preserve variance, covariance and other statistical properties for lower-level variables as well as those for lower-level variables in time or space. Traditional parametric disaggregation models have some drawbacks because they are described based on certain assumption to form of sequential dependence and the form of probability density function. The proposed nonparametric disaggregation model avoids above-mentioned assumption and improves traditional parametric disaggregation model. In this paper, nonparametric disaggregation model was introduced and applied to stochastic simulation for monthly runoff at Ping Shan station in the Sha Jiang River. The results show that the NPDM model applies to hydrologic stochastic simulation.

Key words parametric disaggregation model, nonparametric disaggregation model, stochastic simulation

Avoiding Disputes Arisen in Contracts for Construction

Anthony E. Pugh P. e

(Harza Engineering Company, International, Chicago, U.S.A.)

Zhang Guorong

(Ertan Engineering Corporation, Panzhihua, Sichuan, 617000)

Abstract The paper briefs the background and causes for disputes arisen in contracts for construction of projects with international funds and loans based on I.C.B. procedure. The paper recommends that an Owner should take steps to avoid disputes from the start of preparation of the Tender Documents, and that the Owner should ensure he is prepared to provide the land and money required by the Contractor(s) to once the Notice(s) to commence has (ve) been issued. During the Contract period, he must be ready to make quick decisions on all technical and contractual matters that arise. The paper concludes that it is in neither party's interests to leave potential disputes unaddressed or disputes unresolved. The opinions and recommendations can be referenced by Owners in developing countries.

Key words disputes, contract, Tender Documents, information, tender, settlement of disputes, make quick decisions

Genetic Analysis on Intraformational Faulted Zones of Quartz-acanthonite in Basalt

Zhou Zhidong Su Shengrui

(Chengdu Science and Engineering Institute, Chengdu, 610059)

Abstract In rock mass in dam site areas of numerous hydropower stations at southwest region in China, intraformational faulted zones with low dip angle are generally developed, which play a decisive role in stability of rock mass. At a basalt dam site area, several types of intraformational faulted zones are developed. The genetic analysis on intraformational faulted zones of quartz-acanthonite are discussed preliminarily.

Key words quartz-acanthonite, intraformational faulted zones, genesis