基于虚拟现实的野外地质教学辅助平台建设

西南石油大学地球科学与技术学院

张廷山



目录

一、缘起与意义
二、虚拟野外地质实践教学系统
三、结论

一. 缘起与意义



构建虚拟地学实践教学辅助平台，实现虚拟现实教学，是“新工科”背景下以问题为导向--以学生为中心的创新能力培养方式之重要补充

同时，也避免了诸如天气、人为等因素对野外实习及地质资源的影响。

地质剖面资源共享也是DDE国际大科学计划的目标之一













西南石油大学十分重视虚拟实践教学平台的构建。

在大数据、GIS背景下, 建设虚拟地学实践教学中心,努力实现以问题为导向--以学生为中心的实践教学方法。



四川省教育厅

川教函〔2017〕107号

四川省教育厅关于公布2016年高等学校省级虚拟仿真实验教学中心的通知

省内各普通本科高校：

根据《四川省教育厅关于开展2016年省级虚拟仿真实验教学中心申报工作的通知》（川教函〔2016〕602号）精神，经各学校推荐、专家网评、会议评审答辩，确定电子科技大学智慧物联虚拟仿真实验教学中心等11个中心为省级虚拟仿真实验教学中心，成都体育学院运动医学虚拟仿真实验教学中心等5个中心为省级虚拟仿真实验教学中心培育项目，培育期一年。现将项目名单予以公布（附件1），并将有关事项通知如下：

一、省级虚拟仿真实验教学中心是我省高等学校实验教学研究和改革的基地，有关高校要高度重视实验教学信息化和虚拟仿真实验教学中心的建设工作，加强虚拟仿真优质实验教学资源的建设与共享。同时，要大力开展运行平台、教学队伍和管理机制的建设，提高实验教学管理信息化和支持服务信息化水平。

二、请各项目院校按照本通知要求，结合本校虚拟仿真实验教学中心建设的实际情况，制定《省级虚拟仿真实验教学中心建设项目任务书》(见附件2，以下简称《任务书》)，于2017年3月31日前将《任务书》(一式一份、加盖项目院校公章)报送至教育厅高等教育处，同时发送电子邮件至文件指定邮箱。

三、2016年省级虚拟仿真实验教学中心的建设周期为3年，在此期间，各项目学校应按照《任务书》制定的项目建设规划组织实施，加强过程管理，确保实现建设目标，并按教育厅统一部署，接受项目中期检查与验收。

联系人：高波　联系电话：028-86110643、86110894(传真)

通信地址：成都市青羊区陕西街26号省教育厅高等教育处

邮政编码：610041　电子信箱：scgjsysx@126.com

附件：1. 2016年省级虚拟仿真实验教学中心名单

2. 2016年省级虚拟仿真实验教学中心建设项目任务书

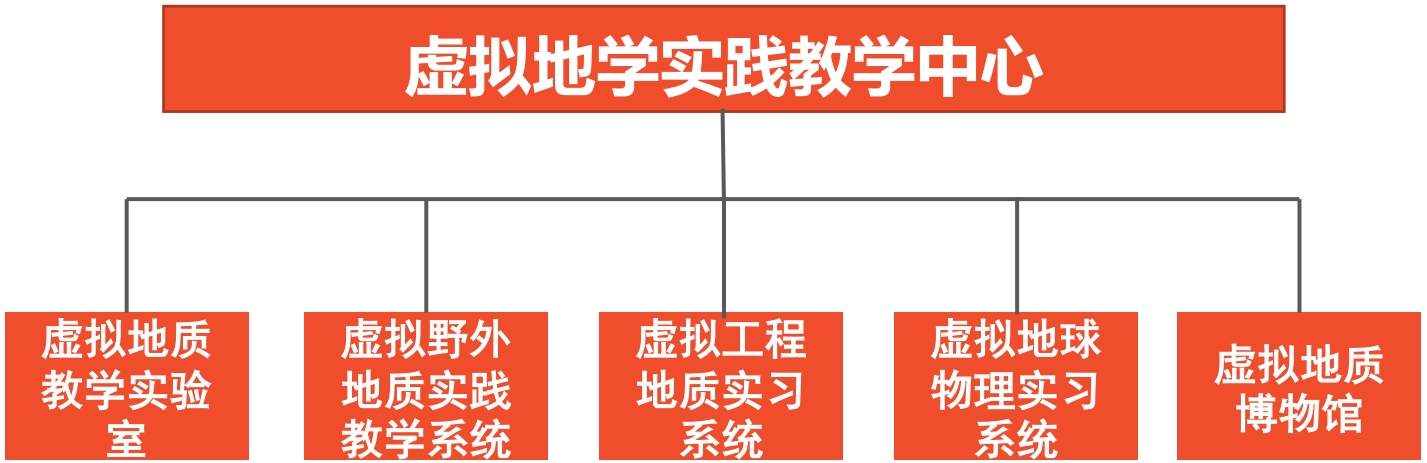
四川省教育厅

2017年3月8日

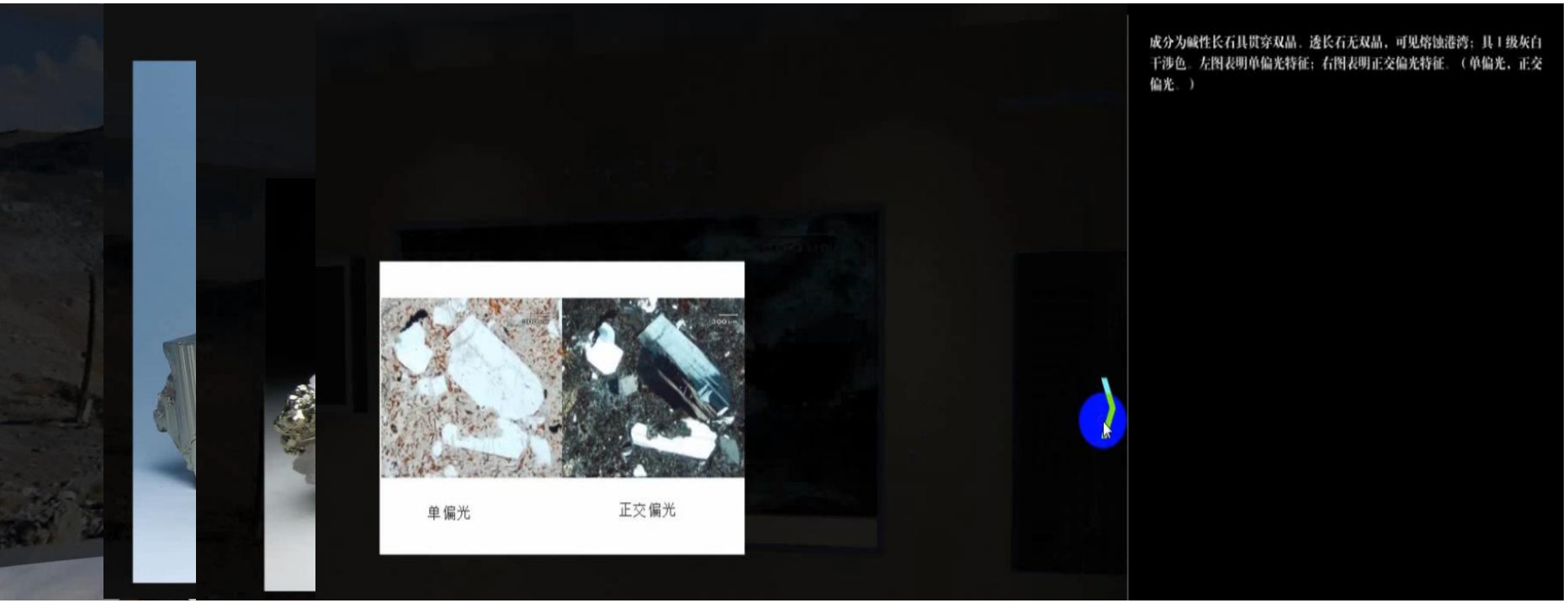
附件1

2016年省级虚拟仿真实验教学中心名单

序号	虚拟仿真实验教学中心名称	所在学校	备注
1	智慧物联虚拟仿真实验教学中心	电子科技大学	获批
2	电气信息虚拟仿真实验教学中心	四川大学	获批
3	核辐射与安全虚拟仿真实验教学中心	成都理工大学	获批
4	基础与应用力学虚拟仿真实验教学中心	西南交通大学	获批
5	地学信息探测与综合应用虚拟仿真实验教学中心	西南石油大学	获批
6	力学与工程安全虚拟仿真实验教学中心	西南科技大学	获批


虚拟地学实践教学中心
虚拟地质教学实验室
虚拟野外地质实践教学系统
虚拟工程地质实习系统
虚拟地球物理实习系统
虚拟地质博物馆

虚拟地质教学实验室


单偏光
正交偏光
成分为碱性长石具贯穿双晶．透长石无双晶，可见熔蚀港湾；具Ⅰ级灰白干涉色．左图表明单偏光特征；右图表明正交偏光特征．（单偏光，正交偏光．）

虚拟野外地质实践教学系统



虚拟工程地质实习系统



虚拟地球物理实习系统



地震资料采集及波场传播数值模拟虚拟仿真实验



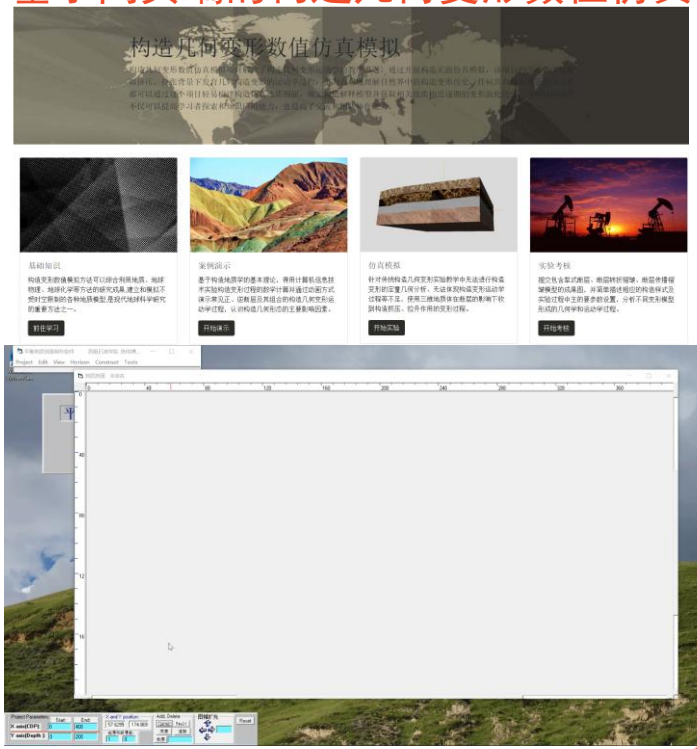
该项目为《地震勘探原理》课程配套虚拟仿真实验教学项目，含采集观测系统设计、激发参数试验、施工过程展示、地下波场传播演示四部分内容。

2019年12月份完成了项目一期陆地采集部分的建设，以及实验入口网站（挂载在国家ILab平台）的建设。

2020年6月份启动了二期海洋采集部分的建设以及实验项目的本地化部署（安装在学校服务器上）。

按计划，全部项目将于8月底完成，并准备申报2020年的国家虚拟仿真实验教学项目。

基于网页端的构造几何变形数值仿真模拟



该项目2018年已获批四川省虚拟仿真教学项目，现准备冲刺国家虚拟仿真项目。可模拟各种构造几何变形的运动学过程。

已完成程序源代码的结构化改造，三维图形展示等工作（见上图）；

虚拟地质博物馆





二. 虚拟野外地质实践教学系统

检索了2005年以来国内外论文、建成的系统等

第29卷 第3期
2010年9月
世 界 地 质
GLOBAL GEOLOGY
Vol. 29 No. 3
Sept. 2010

文章编号：1004－5589（2010）03－0522－05

虚拟野外地质实习系统（VFGTS）

——野外地质实践教学平台

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吉林大学 地球科学学院，长春 130061

摘要：虚拟野外地质实习系统是根据野外地质教学实践性特点，采用计算机图形、图像和多媒体技术模拟野外地质教学过程的软件系统，具有三维野外地质场景显示、多媒体、虚拟记录本、直观地质过程模拟、飞行漫游、GPS、罗盘和学习效果测验等功能，是重要的野外地质教学平台，对辅助野外地质教学，提高野外地质教学效率和质量，改变传统教学观念具有重要作用。

关键词：野外地质实习系统；教学改革；虚拟

中图分类号：P621.5；T15　　文献标识码：A　　doi：10.3969/j.issn.1004-5589.2010.03.023

Virtual field geological trip system （VFGTS）

—teaching platform of field geological practice

技术创新　　内江科技 2013年第2期 96

基于W eb的虚拟野外地质实习系统设计与实现

祝德显

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摘　要　本文从野外地质实习的教学现状出发，分析了野外地质实践教学的特点和建立虚拟地质实习平台的意义，基于虚拟实验室思想，采用百度地图API、Jquery、Extjs框架技术，设计并实现了模拟野外地质教学过程的基于Web环境的虚拟野外地质实习系统，具有野外地图导航、地质场景相册、实习路线管理、地质构造三维模拟等功能，为提

J Sci Educ Technol (2013) 22:351–361
DOI 10.1007/s10956-012-9398-4

Determining Virtual Environment “Fit”: The Relationship Between Navigation Style in a Virtual Field Trip, Student Self-Reported Desire to Visit the Field Trip Site in the Real World, and the Purposes of Science Education

M. Shane Tutwiler · Ming-Chao Lin · Chun-Yen Chang

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© Springer Science+Business Media, LLC 2012

Abstract In this study, a follow-up analysis of the data reported in Lin et al. (Learn Media Technol. doi: 10.1080/17439884.2011.629660, 2011), we investigated the relationship between student use of a virtual field trip (VFT) system and the probability of students reporting wanting to visit the national park site upon which the VFT was modeled, controlling for content knowledge and prior visits to the park. Students who were able to navigate the VFT in teams were more likely than their peers who had the system demonstrated by a teacher to want to visit the national park. In addition, students with higher pre-intervention content knowledge were more likely to want to visit the national park than their peers with lower pre-test scores, in both the teacher demonstration and student co-navigation conditions.

Keywords Virtual learning environments (VLEs) · Virtual field trips (VFTs) · Virtual reality (VR)

Introduction

It has been suggested, based on student performance, that traditional classroom science education does not provide the framing necessary for students to fully develop scientific inquiry skills (Krajcik and Blumenfeld 2006). One aspect of that necessary framing, as suggested by multiple theories of inquiry, is providing students the ability to engage in data collection in authentic environments (Chinn and Brewer 2001; National Research Council 2005; White and Frederiksen 1998). This has traditionally been accomplished in the K-16 education setting through the use of field trips. However, students on field trips to novel sites are often placed under heavy cognitive loads that limit their ability to perceive and process all of the relevant information (Falk et al. 1978). It is therefore ideal that students be motivated to want to independently visit data-rich areas such as those they may be exposed to on field trips. However, taking trips to field sites can often be difficult due to climate and terrain. Take, for example, the case of Taiwan.

Located on the western border of the Pacific Ring of Fire, Taiwan is a subtropical mountainous island with a population of 23 million people. The island's proximity to tectonically active areas makes it prone to earthquakes and tsunamis, but also accounts for rich geological diversity. National parks on the island range from beaches and rainforests to volcanoes and snow-capped mountains. While many Taiwanese students are able to visit the low-lying beach and forest regions, visits to the mountainous and volcanic regions are far less frequent. Inclement weather in the mountainous regions of Taiwan is often a contributing factor to the relative lack of visitation, as is the difficulty of accessing the parks via winding and often tortuous roads.

In this study, we begin to address questions surrounding what factors in a virtual-environment-based Taiwanese high school science curriculum might be related to student desire to actually visit the lesser-attended national park areas. Here, we simulated one of these areas using a virtual environment and then assessed whether students who were

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Vol. 37, No. 5
May., 2014

基于 GIS 的虚拟地学实习演示系统设计与实现

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摘　要：传统地学实习存在诸多弊病，为使其符合现代教学的需求，特构建虚拟地学实习演示系统。本文在分析地学实习教学现状的基础上，基于 GIS 对虚拟地学实习演示系统进行了设计，确定了系统目标和系统架构，对系统的功能、软件模块、数据组织和系统界面进行了设计，为野外地学实习提供了有效的辅助作用。

关键词：GIS；地质地理实习；地质教学；虚拟现实

中图分类号：P208　　文献标识码：B　　文章编号：1672－5867(2014)05－0071－03

Design and Implementation of Virtual Geoscience Practice Demonstration System Based on GIS

SHU Juan, WANG Jing, LONG Chang-fu, XU Jian, YU Hui-juan
（School of Geosciences, Yangtze University, Wuhan 430100, China）

Abstract: As traditional geological practice has many flaws, constructing virtual learning practice demonstration system is r conforms to the requirements of modern teaching. In this paper, we designed the Virtual Geoscience Practice Demonstration GIS and determined the system target and architecture, also the function of the system software module, data organization a interface design. It was based on the analysis of the present situation of geological practice teaching, provides the field stud the effective auxiliary.

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Vol. 32 No. 7 Jul. 2015

野外地质实习辅助教学系统设计与开发

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2009 Ninth IEEE International Conference on Advanced Learning Technologies

3D Compound Virtual Field Trip system and its comparisons with an actual field trip

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Department of Earth Sciences, National Taiwan Normal University, Taipei, Taiwan
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Abstract

This article delineates an online 3D Compound Virtual Field Trip (3D-CVFT) system developed by us and compares the 3D-CVFT with an actual field trip.



Teaching Military Geoscience in the Twenty-first Century Classroom: Virtual Field Explorations of the Gettysburg Battlefield

W. Lee Beatty and Candace L. Kairies-Beatty

Abstract Access to the internet in today's classrooms has opened the door to a variety of new pedagogies that enhance learning in the geosciences while being easily adopted with minimal investment. Web-based virtual tours, explorable gigapixel panoramas, GIS and Google Fusion Tables allow users access to a wealth of information for conducting in-depth investigations and analyses of locations that are impractical to visit due to time or budgetary constraints. Several of these emerging techniques have been combined to bring field investigations of battlefield terrain into the classroom through virtual fieldwork. The Battle of Gettysburg, the largest ever fought in North America, was significantly influenced by the topography and geology of the farmland surrounding the small Pennsylvania town. This makes the battlefield an excellent venue for teaching the impacts of geology and landscapes on military operations. Several Gettysburg-based projects have been developed to introduce concepts of military geoscience to students and the public and integrate virtual fieldwork into the classroom. One virtual tour of the battlefield (https://sites.google.com/site/gettysburggeologyfieldguide/home) utilizes a traditional web-page platform to explore the effects of geology and topography on the fighting

Using Interactive Virtual Field Guides and Linked Data in Geoscience Teaching and Learning

Tim Stott, Kate Litherland, Patrick Carmichael, and Anne-Marie Nuttall

Abbreviations

EPSRC	Engineering and Physical Sciences Research Council
ESRC	Economic and Social Research Council
FTP	File transfer protocol
GEON	Geosciences Ontology
GOSIC	Global Observing Systems Information Center
HEP	Hydroelectric Power
LJMU	Liverpool John Moores University
NASA	National Aeronautics and Space Administration
SEM	Scanning Electron Microscope
USGS	United States Geological Survey
VFG	Virtual Field Guide
WHO	World Health Organization

1 Introduction

The benefits of teaching and learning through fieldwork have long been recognised by educators in schools and universities (e.g. Andrews et al. 2003), and the notion of supporting fieldwork with web-based and mobile technologies in the Geography, Earth and Environmental Science (GEES) disciplines (e.g. Stott 2007) has been

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V.C.H. Tong (ed.), *Geoscience Research and Education: Teaching at Universities*, Innovations in Science Education and Technology 20, DOI 10.1007/978-94-007-6946-5_13,
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基于RIA的全景虚拟野外地质信息系统

Panoramic Virtual Field Geological Information System Based on RIA

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指导教师：薛林福 教授
学位类别：理学博士
培养单位：吉林大学地球科学学院
论文答辩日期：2010 年 6 月 3 日
授予学位日期：2010 年　月　日
答辩委员会主席：
论文评阅人：

（一） 三维虚拟仿真方法

以北京大学、Harvard University, National Taiwan Normal University为代表

虚拟地质野外实习系统操作简介

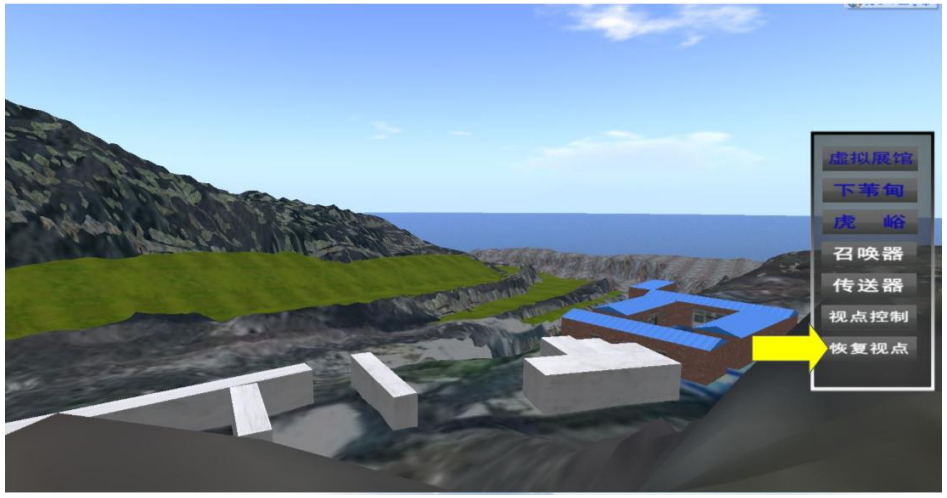
陈斌
北京大学地球与空间科学学院
2016-5-25





1、北京大学虚拟地质野外实习系统







纯虚拟方式，通过传统建模手段，
后期场景更新繁琐、缺乏真实坐标系统，
地质现象用照片表达。

野外地质数据采集工作量小

2、Harvard University, National Taiwan Normal University(2013)

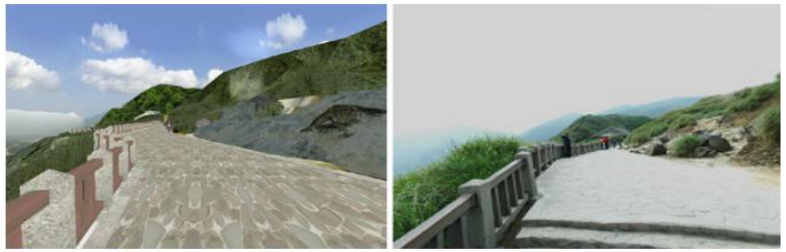


Fig. 1 VFT (*left*) and actual (*right*) images of the Hsiaoyukeng Walking Area

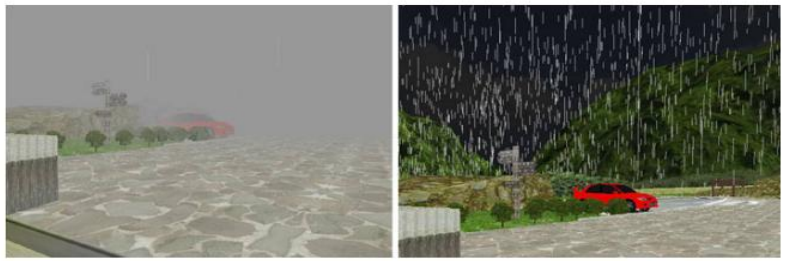


Fig. 2 Foggy (*left*) and rainy (*right*) conditions outside of the visitor's center in the VFT



Fig. 4 Outdoor walking area of the VFT. Vapor fumaroles are visible in the background



Fig. 5 NPC in the VFT calling attention to a pool of bubbling water

北京大学系统(2016)与其类似

(二) 地质现象的实景展示方法

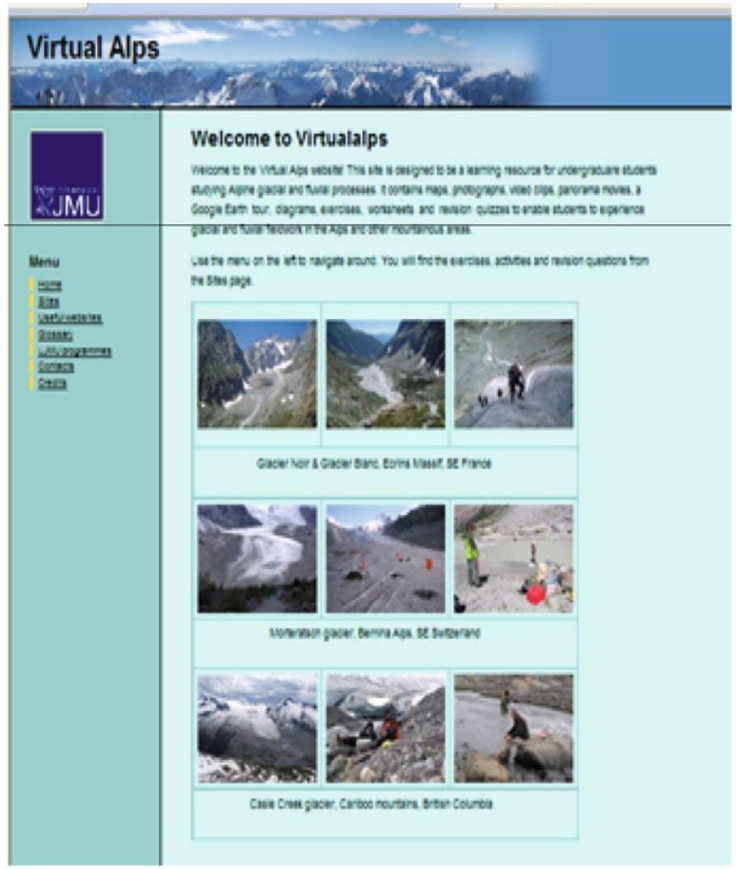


Fig. 2 The 'Virtual Alps' VFG home page (www.virtualalps.co.uk)

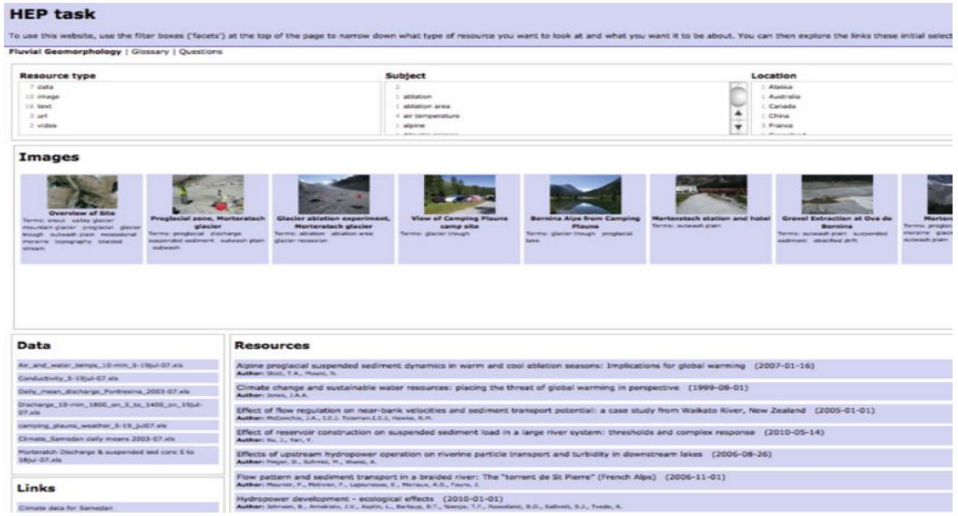


Fig. 8 Virtual Alps as a linked data portal (http://www.ensemble.ac.uk/projects/settings/outdoor/HEP/index.html, accessed 1 Oct 2011)

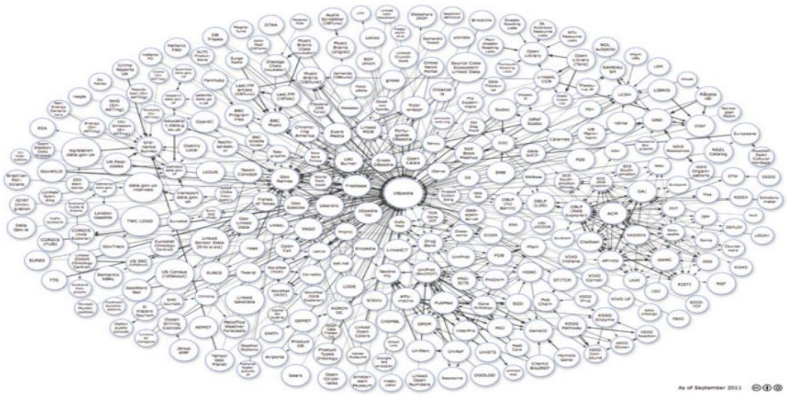
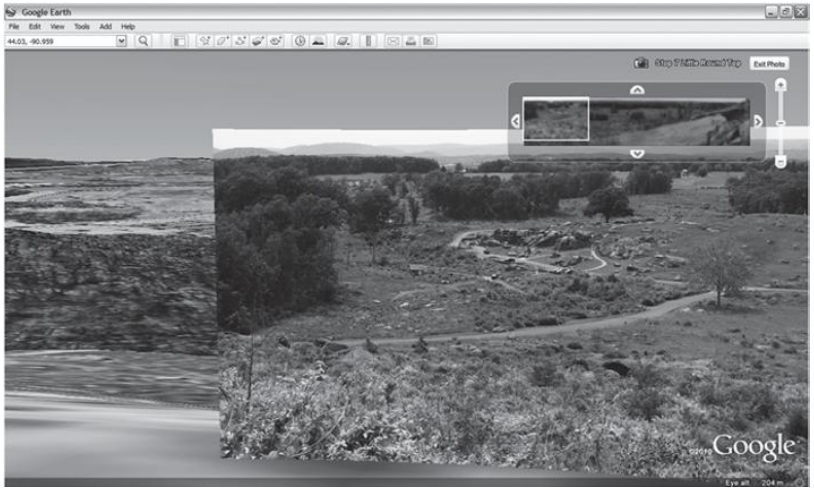


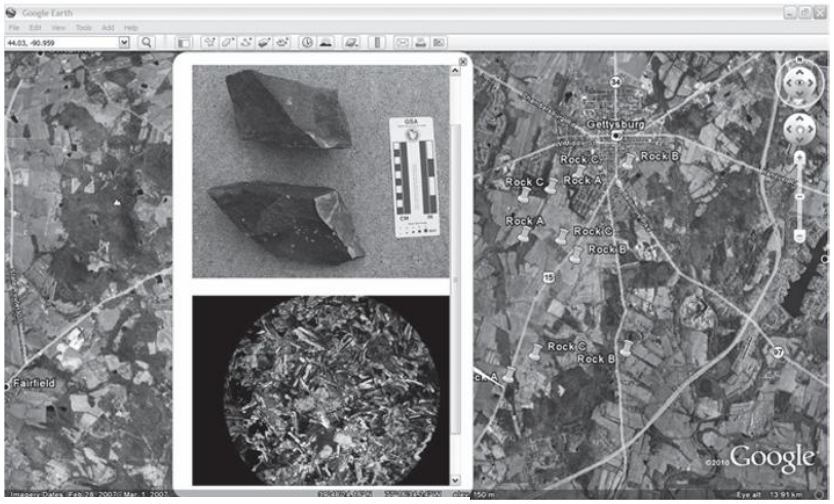
Fig. 6 The Cyganiak-Jentzsch linking open data cloud diagram, September 2011 (http://richard.cyganiak.de/2007/10/lod/lod-datasets_2011-09-19.png, accessed 15 Dec 2011)

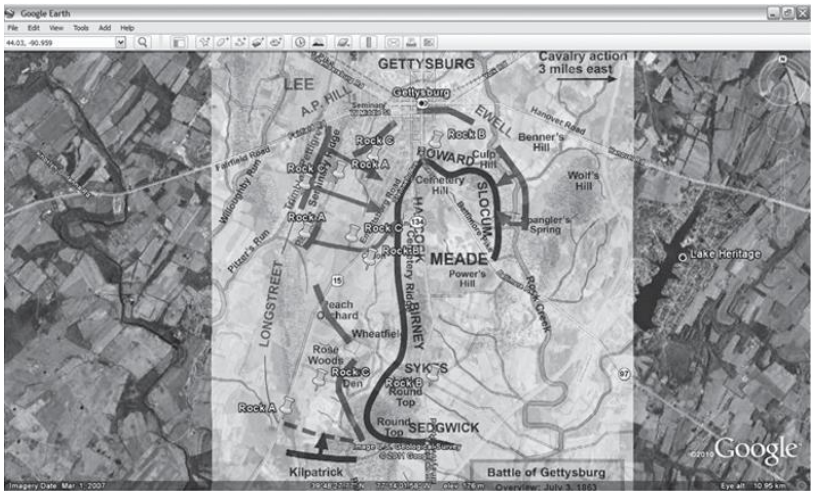
Liverpool John Moores University虚拟地质野外实习系统(2014)

基于云端资料，高速internet及全球开放的资料库

（三） 二维仿真+宏观、微观查询方法







Teaching Military Geoscience in the Twenty-first Century Classroom: Virtual Field Explorations of the Gettysburg Battlefield

W. Lee Beatty and Candace L. Kairies-Beatty

Abstract Access to the internet in today's classrooms has opened the door to a variety of new pedagogies that enhance learning in the geosciences while being easily adopted with minimal investment. Web-based virtual tours, explorable gigapixel panoramas, GIS and Google Fusion Tables allow users access to a wealth of information for conducting in-depth investigations and analyses of locations that are impractical to visit due to time or budgetary constraints. Several of these emerging techniques have been combined to bring field investigations of battlefield terrain into the classroom through virtual fieldwork. The Battle of Gettysburg, the largest ever fought in North America, was significantly influenced by the topography and geology of the farmland surrounding the small Pennsylvania town. This makes the battlefield an excellent venue for teaching the impacts of geology and landscapes on military operations. Several Gettysburg-based projects have been developed to introduce concepts of military geoscience to students and the public and integrate virtual fieldwork into the classroom. One virtual tour of the battlefield (https://sites.google.com/site/gettysburggeologyfieldguide/home) utilizes a traditional webpage platform to explore the effects of geology and topography on the fighting, while another (https://sites.google.com/site/gettysburgvirtualfieldwork/home) uses the unique interactive environment of Google Earth, with traverses, annotations, and immersive high-resolution panoramas that give the user a soldier's-eye view of the terrain. In-depth investigations of the battlefield can be conducted in the classroom with rock samples (both physical samples and 3D scans), topographic maps, explorable gigapixel petromicrographs, and geolocated GigaPan panoramas of the battlefield (www.gigapan.com). Students are provided samples representing the prominent rocks of the Gettysburg area and topographic maps with marked field stops. They orient themselves using Google Earth, make field observations (including locations of outcrops, weathering patterns of rocks, and topography), and identify rocks in outcrop. After compiling their data and creating a geologic map, they investigate how geology and topography affected the strategies of the Union and

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美国Winona State University虚拟地质野外实习系统(2016)为代表

基于Google Earth实现，二维电子地图+手标本及镜下照片方式实现。建设周期短。缺乏三维实景剖面支撑。

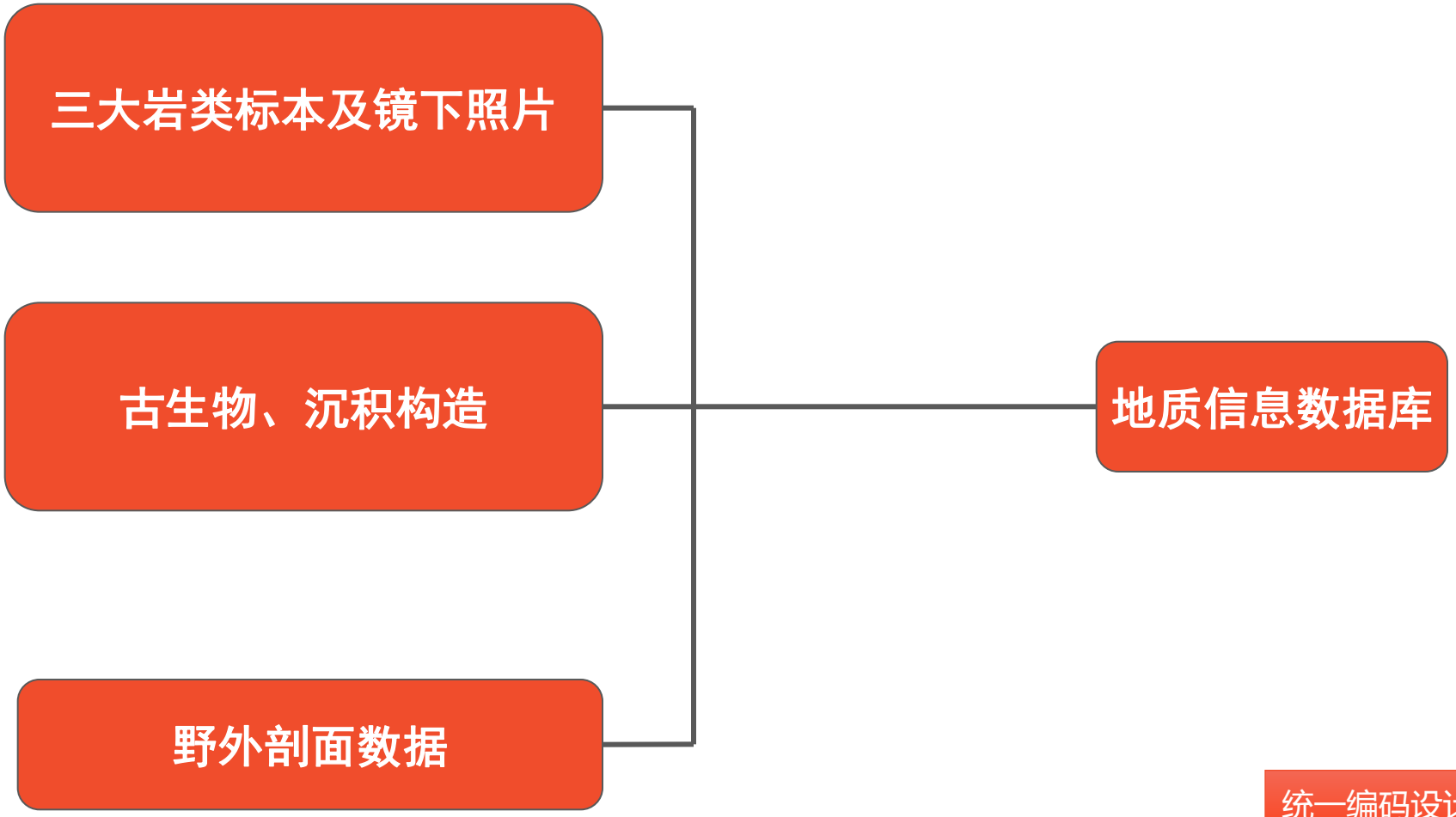
南大、地大(北京)、石油大学(华东)



虚拟野外地质实践教学系统

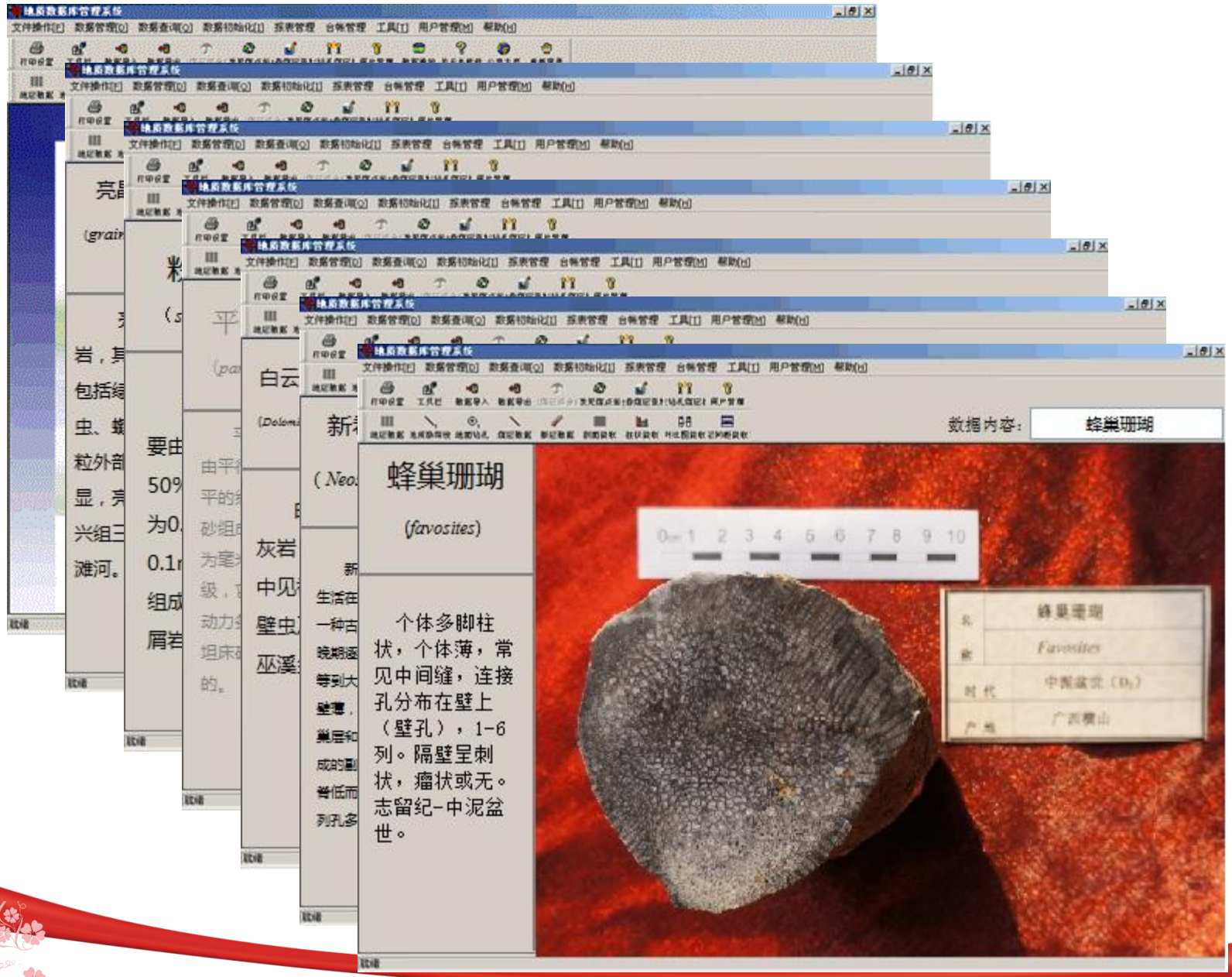
以问题为导向的地质剖面三维实景+宏观、微观查询平台

标本、薄片作为系统支撑素材

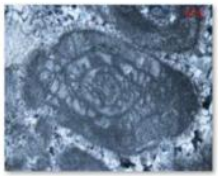


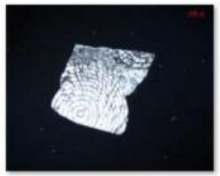
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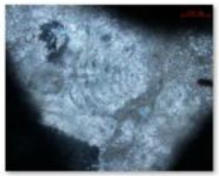
地质信息数据库

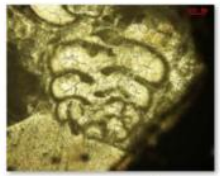

地质数据库管理系统
数据内容：
蜂巢珊瑚
蜂巢珊瑚
(favosites)
个体多脚柱状，个体薄，常见中间缝，连接孔分布在壁上（壁孔），1-6列。隔壁呈刺状，瘤状或无。志留纪-中泥盆世。

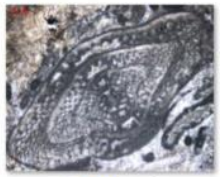
整理标本、薄片等1000余套作为系统支撑素材


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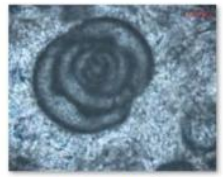

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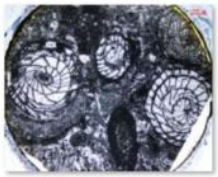

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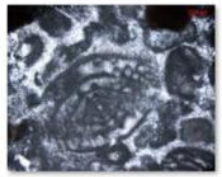

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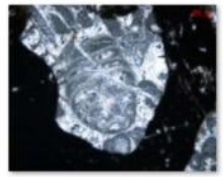

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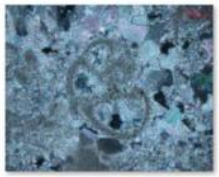

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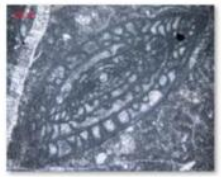

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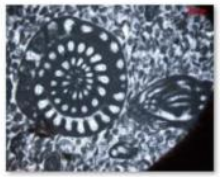

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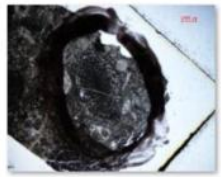

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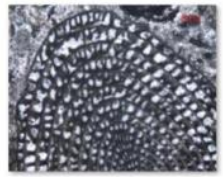

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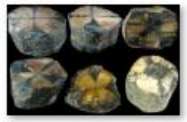

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实现野外地质剖面的三维实景展示

野外地质剖面实景展示方法

一、利用照片全景图来展示地层剖面

二、利用三维激光扫描对地质体建模

三、基于无人机倾斜摄影测量的三维建模

利用照片全景图来展示地层剖面

优点：

1 数据采集操作简便

2 全景图能较真实的反应地质体信息

缺点：

1 图像有一定的几何变形

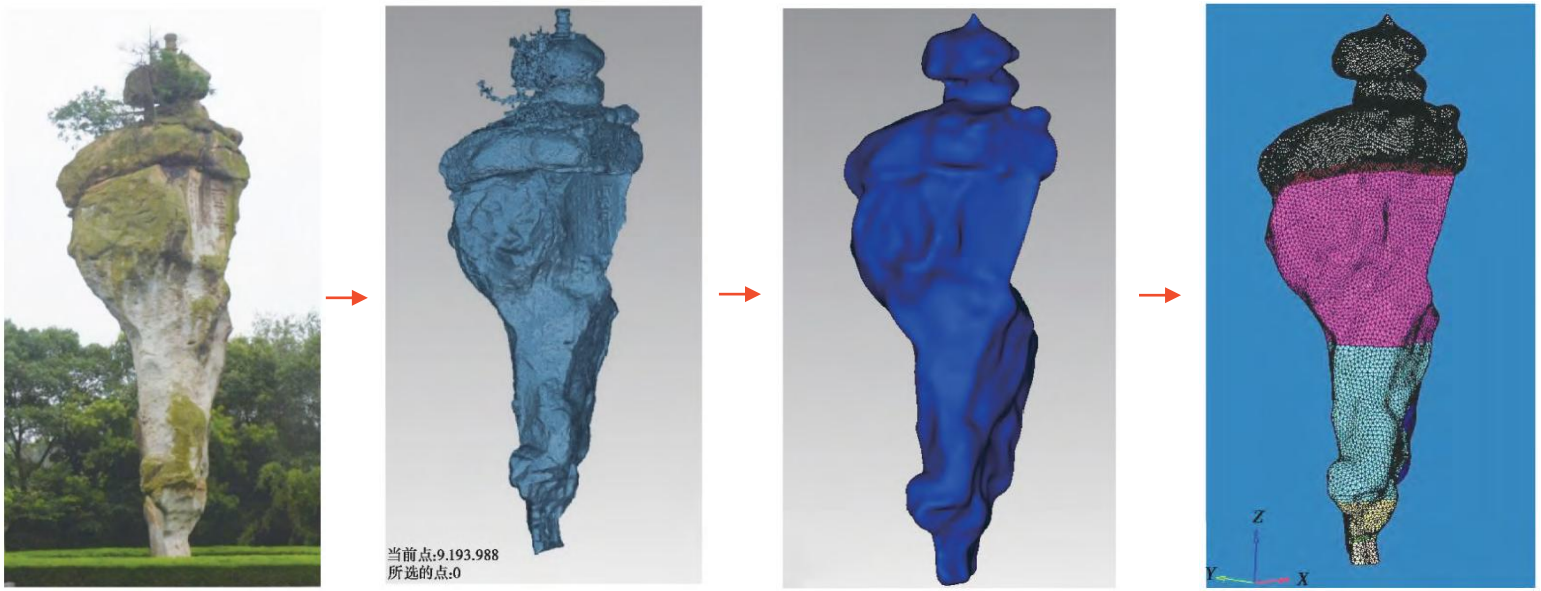
2 对于较远的目标体，分辨率不能足够到反应地质体细节。

3 二维、无坐标





利用三维激光扫描对地质体建模



优点：1、根本上解决了在描述复杂三维地质体几何信息时数据不足、精度不够的问题 。

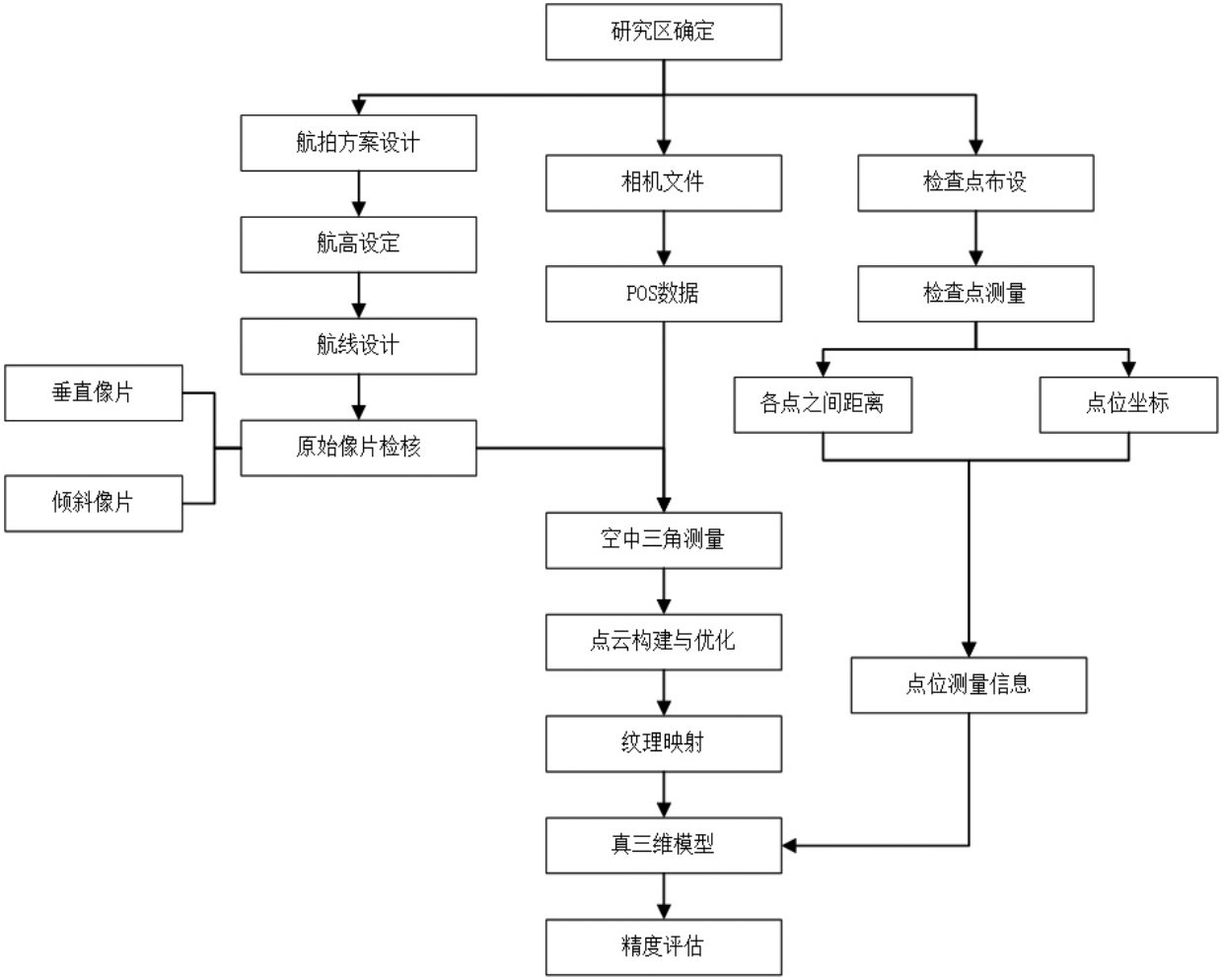
2 实现了复杂地质三维体在可视的同时也可进行编辑。

缺点：1、 虽然通过大量点云构建出了精度较高的模型，但保真度不高。

2、 在野外进行数据采集耗时过长，效率相对较低。

基于无人机倾斜摄影测量的三维建模

无人机倾斜摄影测量技术是指在无人机平台上搭载相机进行**多角度拍摄以获取地表信息**的技术手段，它能够**快速高效地获取地面高分辨率影像**，并通过计算机视觉匹配、区域网联合平差、纹理映射等技术构建三维模型，目前已经广泛应用于城市规划，国土资源勘探等领域。



基于无人机倾斜摄影测量的三维建模

优点：

1. 无人机3D建模效率高

2. 可以快速获取地表数据进行建模数据分析

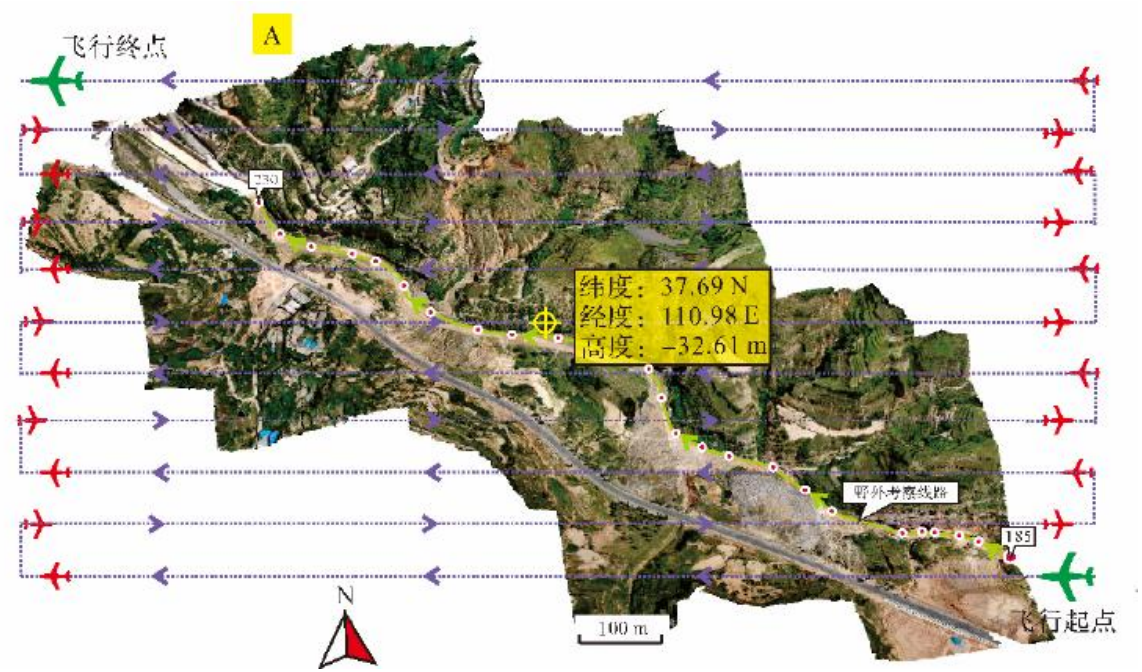
缺点：模型生成途中不能进行编辑。



基于无人机倾斜摄影测量的三维建模

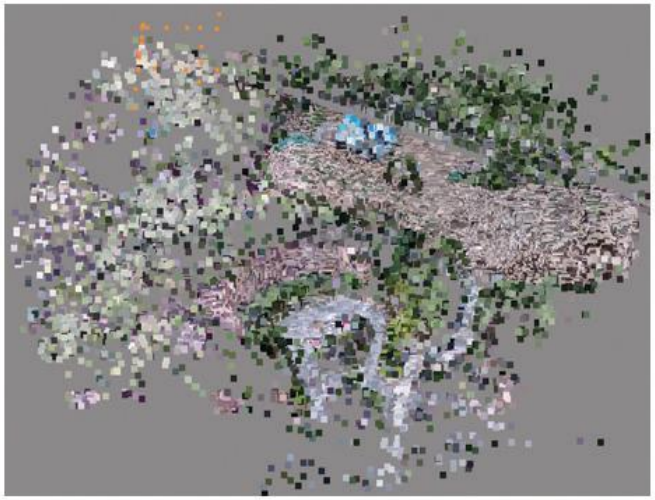
特征匹配与空中三角测量

1、通过生成高斯差分金字塔进行尺度空间的构
建；
2、关键点的初步探查与精确定位；
3、关键点主方向的确定；
4、对关键点进行特征描述与匹配。

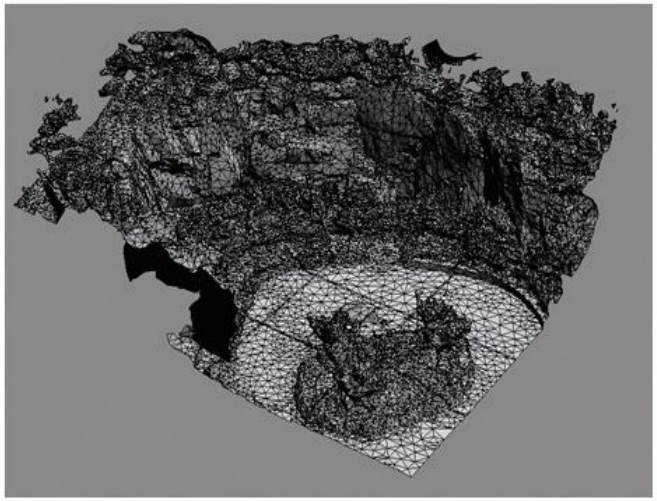


基于无人机倾斜摄影测量的三维建模

密集点云及不规则三角网模型的构建



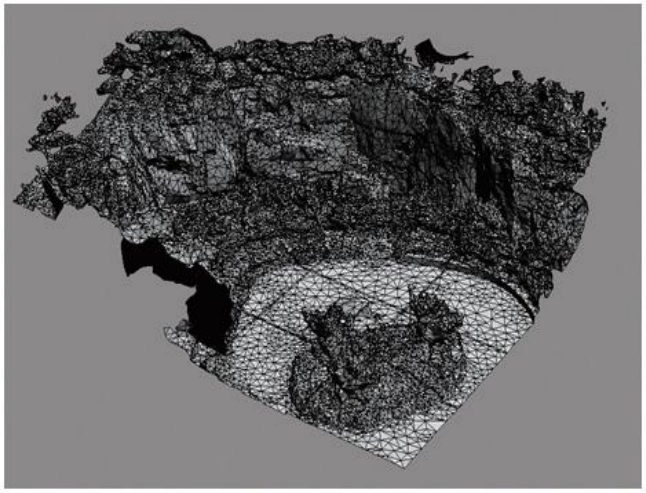
点云



不规则三角网（TIN）

纹理映射

纹理贴合是构建真实三维模型的重要部分，是在前期构建的三维模型基础上，将包含实际纹理的信息映射到模型上。



不规则三角网（TIN）



地质露头三维实景模型（由TIN经过纹理映射）

基于无人机倾斜摄影测量的三维建模



贵州永宁剖面关岭组一段模型
（T_2g^1）



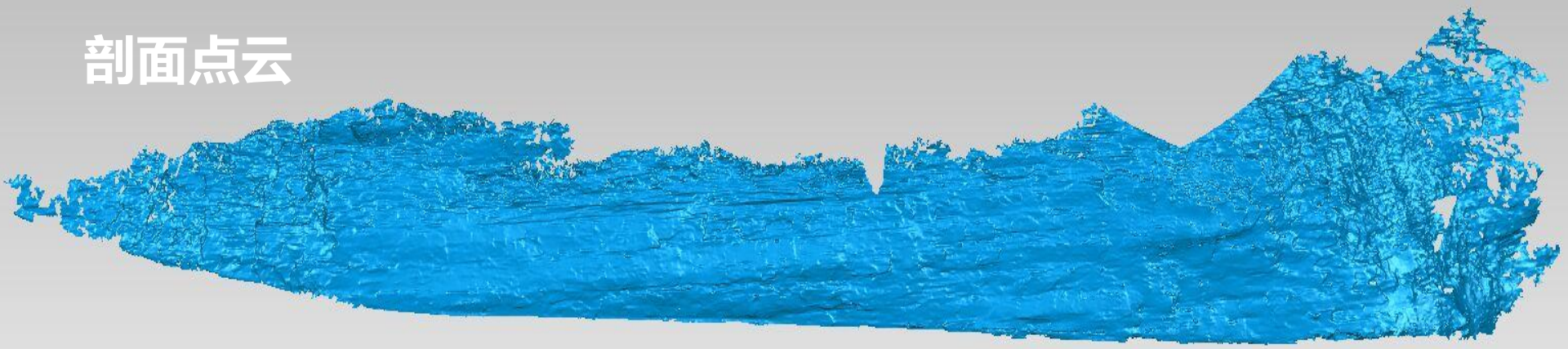
贵州永宁剖面法郎组竹竿坡段模型
（T_3z）

虚拟野外地质实践教学系统
---旺苍实习剖面

采集、处理旺苍数字化剖面



剖面点云

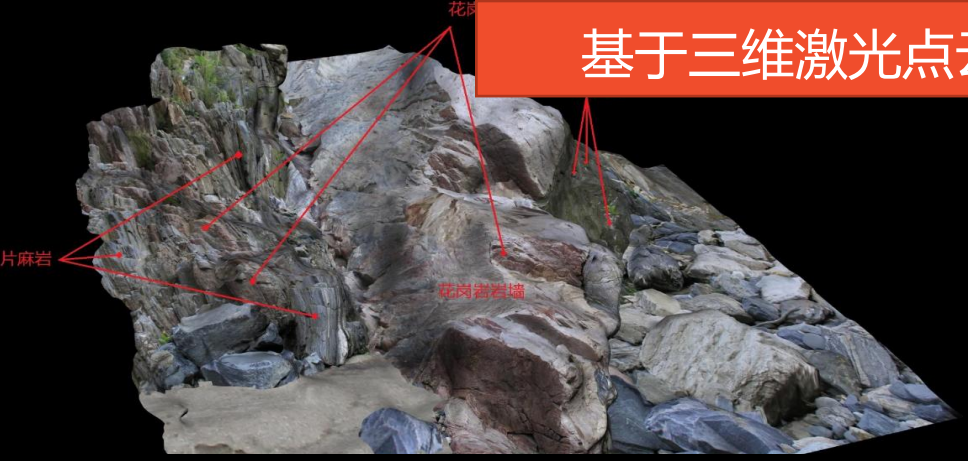


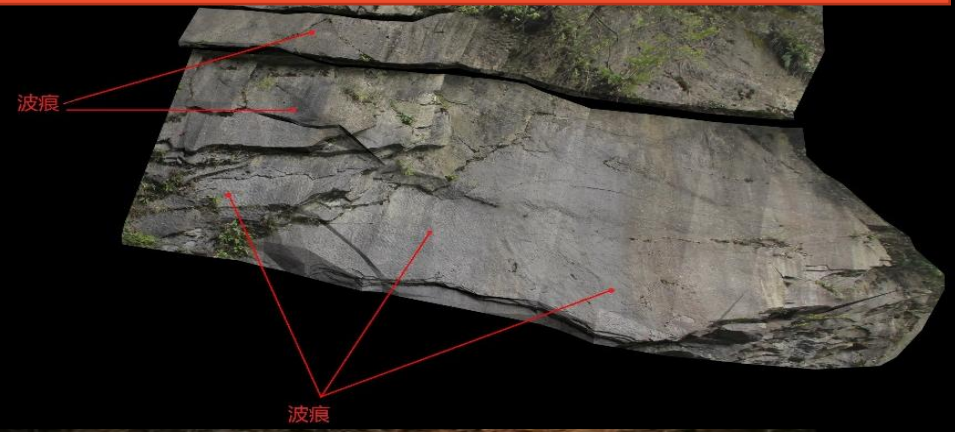
剖面建模



野外地质数字化剖面宏观尺度观测

基于三维激光点云技术，实现了典型实习剖面的建模



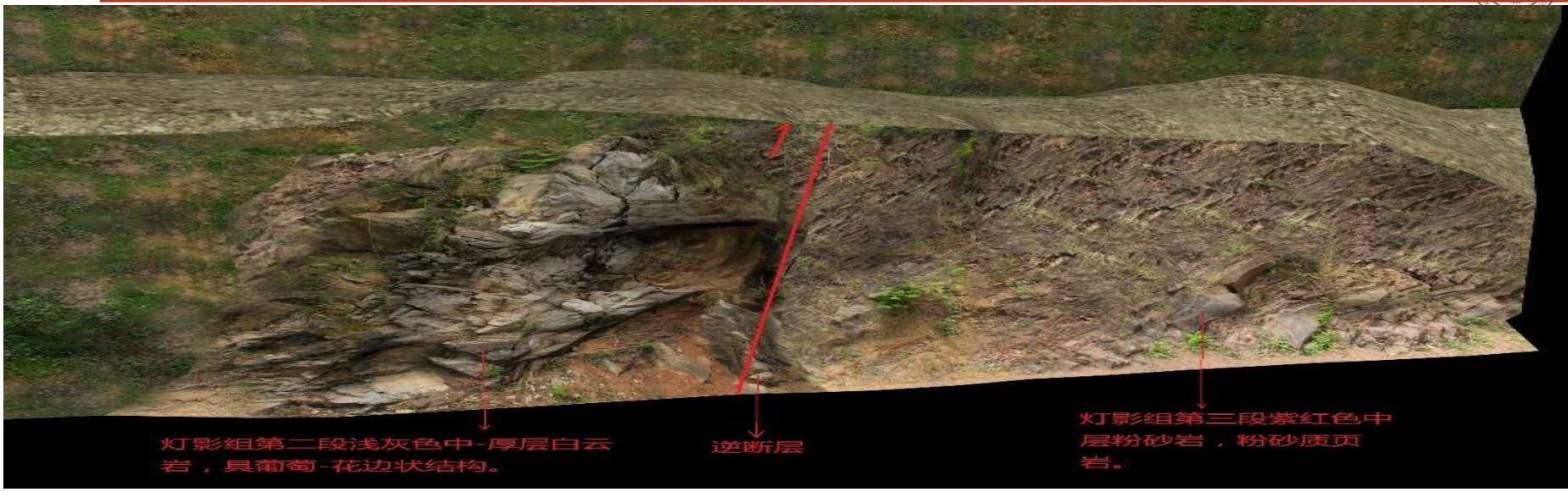







Home Page - Windows Internet Explorer
Home Page

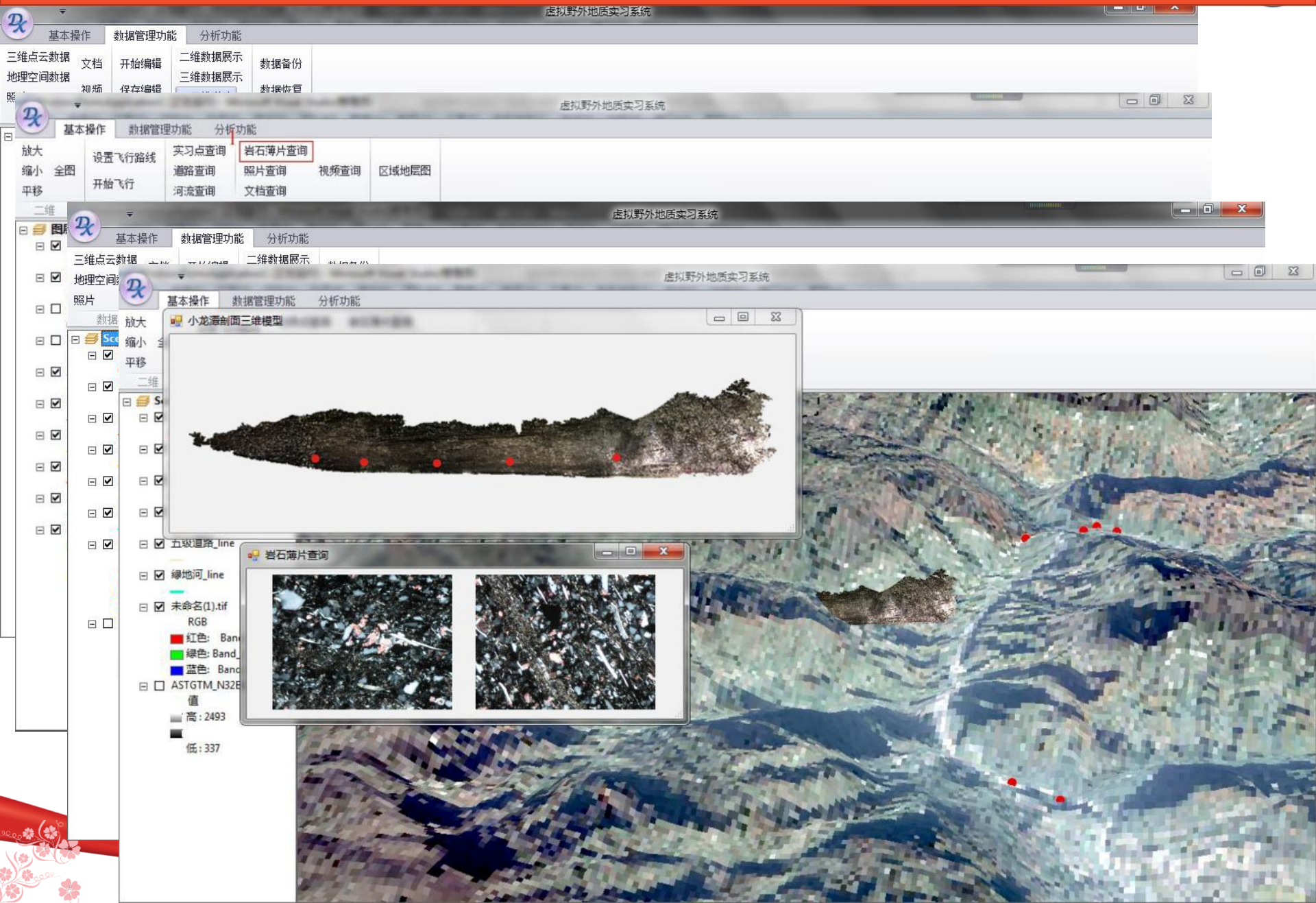
旺苍实习基地剖面虚拟互动系统演示





初步建立基于GIS&RS的旺苍虚拟野外地质实习系统

基于GIS&RS的旺苍实习基地虚拟野外地质实习系统



三、结论

1、问题为导向：为学生提供了**实习前、实习后、实习中多维**教学资源。通过激光三维扫描、无人机倾斜摄影等技术精细刻画野外地质现象、**提升学生学习兴趣**。

2、**延伸服务**：与“互联网+”应用融合，为米仓山自然保护区在地质景观保护、旅游资源推介、科普基地建设、科研工作站支撑平台建设等领域提供了拓展空间。

也是DDE国际大科学计划的目标之一


谢谢