大地电磁电导率仪

Electromagnetic Conductivity Meters

ADMT系列

ADMT EH Series

使用说明书

Instructions Manual

上海艾都慧测智能科技有限公司

Shanghai Aidu Intelligent Detection Technology Co. Ltd

目录

Contents

注意

本产品在正式测量前，请不要长时间开机，或者在开机的情况下充电，上述行为会 影响产品的实地使用，严重时将导致产品无法测量!

适用范围

本操作手册适用 ADMT 系列大地电磁电导率仪的型号分别有：EH8、EH6、EH4、EH2、EH1

用户须知

非常感谢您选择使用上海艾都慧测智能科技有限公司出品的大地电磁电导率仪设备（以下简称设备）。在使用本产品前，请您仔细阅读本产品手册。本手册涵盖产 品使用的各项重要信息及数据，用户须严格遵循本手册中的各项规定，方可保证 设备的正常运行。

手册概况

本手册对设备的操作和维护等内容做了详细的说明，同时阐述了设备的测量原理 仪器构成和性能特点，为受过专门培训或具有仪器操作控制相关知识（例如自动化技术）的技术人员提供准确的使用参考。

章节	内容
一、测量系统概述	阐述仪器的基本情况
二、仪器主要特点	主要介绍仪器技术特点
三、仪器工作原理简介	主要介绍仪器的工作原理
四、仪器介绍及技术参数	主要介绍仪器的构成和参数
五、软件界面功能介绍	界面功能及如何登录和注册
六、数据测量操作	仪器的测量步骤
七、绘图操作方法	如何使用数据进行绘图
八、仪器野外连接方法	仪器在野外的连接方法
九、使用仪器的注意事项	对仪器的使用注意事项说明

一、测量系统概述

ADMT 系列大地电磁电导率仪测量系统分为 EH8、EH6、EH4、EH2、EH1 等五个型号产品，分别满足测量地下 8000、6000、4000、2000、1000 米深度的特殊大地电磁测深（MT）仪器，既可测量天然场源的大地电磁信号，响应频率 0.001~2K Hz，也可以使用人工场源的电磁信号，以此来获得测量点下的电性结构。

EH8、EH6、EH4、EH2、EH1 等大地电磁电导率仪测量系统是通过同时测量当点不同频率的电场 Ex、Ey 和电磁场 Hx、Hy 来获得地下不同深度的电阻率，不同频率的电场经过 MN 电极、不同频率的电磁场经过高精度的磁棒和前置积分放大电路，同时采集到仪器里，经过傅立叶变换、平滑滤波、中值修正等数据处理后，得到该点电阻率数据。虽然在野外测量要经过几分钟到几十分钟，但得到的电阻率，可以对测量点地下电性分层的比较合理估计。

EH8、EH6、EH4、EH2、EH1 等大地电磁电导率仪测量系统由接收操　控主机、Ex 和 Ey 电场测量主机、Hx 和 Hy 电磁场测量主机及电磁传感器(探棒）、MN 电极及其他配件组成，采用 Wifi 无线连接、防水设计等，一些特殊应用场景可以配置发送机使用，可以在高频段、天然信号通常比较微弱，　使用发射机能够提高数据的质量。

EH8、EH6、EH4、EH2、EH1 等大地电磁电导率仪测量系统在系统设 定的最大深度范围内，可根据需要的勘探深度要求来选择，仪器自动调整到该深度勘探的合理配置参数。广泛用于地下水、地热温泉、金属矿产、石油天然气等资源的普查和详查，工程物探、地质灾害调查等。具有全无线连接、操作简单、实时自动成图分析等优点，并且数据及时备份云端，提供远程下载制图分析，实时监控数据采集质量。

EH8、EH6、EH4、EH2、EH1 等大地电磁电导率仪测量系统的核心技术获得过多项发明专利（专利号：201310205318.9、201320054153.5、201120214308.8、201320303919.9），荣获上海市高新技术成果转化项目认定。二十多年里，大量实践证明在 1000 米内与直流电法类仪器对比试验，获得非常好的异常曲线一致性；在全程深度与行业进口同类型产品相比，稳定性、可靠性及抗干扰能力上有很大改善，在智能化、简便化方面大幅度提升，得到广大客户的认可和支持。

二、仪器主要特点

1、实时自动成图分析：集数据采集、处理、成图为一体，现场及时绘制测深曲线图、剖面图及等值 线剖面彩图，实时出分析结果和对数据采集质量把控；

2、智能简便：系统优化仪器参数设置、数据采集和处理，全部智能化完成，简便的设置、　测量后能获得有效的数据和图像；

3、深度可选：在该型号最大深度范围内的深度可选设置测量；

4、数据共享：实现了远程和现场在手机、操控主机、PC 主机等终端设备实现数据共享。

三、工作原理介绍

EH8、EH6、EH4、EH2、EH1 等大地电磁电导率仪测量系统利用大地 天然电磁场作为工作场源的 MT 电法，研究地球内部的电性结构，依据不同 频率的电磁波在导电媒质中具有不同趋肤深度的原理，在地表测量由高频 至低频的地球电磁响应序列，研究地下不同深度地质体的电性变化差异， 确定地下地质体的赋存状态。

3.1 亥姆霍兹方程

地面电磁波发送到地下，电磁波在岩土中的传播遵循 Maxwell 方程。如果假设大多数地下岩土为无磁性物质，并且宏观上均匀导电，不存在电荷积累，那么 Maxwell 方程就可简化为：

$$\left.\begin{aligned}\nabla^2 H + k^2 H = 0\\ \nabla^2 E + k^2 E = 0\end{aligned}\right\} \qquad (1)$$

式中 k 称为波数（或传播系数）。

$$k = [\omega^2 \mu\varepsilon - i\omega\sigma\mu]^{\frac{1}{2}} \qquad (2)$$

考虑到传播系数 k 为复数，令 K=b+ia，其中 a 称为相位系数，b 称为吸收系数。EH8、EH6、EH4、EH2、EH1 不同型号是根据最大深度设定、电磁传感器（探棒）传感器频率响应范围来调整设定合理的仪器放大电路和滤波、平滑等数据处理方法等，频率范围、核心频率点在不同地区进行合理优化，频率大范围在 0.001Hz~2K Hz。

3.2 波抗阻与电阻率

有亥姆霍兹方程变化的磁场感生出变化的电场，我们有磁电关系：

$$\frac{E}{H} = -\frac{i\omega\rho}{k} \qquad (3)$$

表面阻抗 Z 定义为地表电场和磁场水平分量的比值。在均匀大地的情况下，此阻抗与入射场的极化无关，和地电阻率以及电磁场的频率有关：

$$Z = \frac{E}{H} = \sqrt{\omega\mu\rho}e^{i\pi/4} \qquad (4)$$

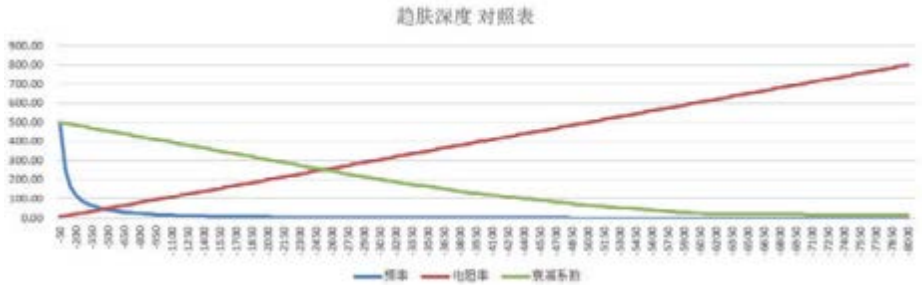
公式(4)可用于确定大地的电阻率。

$$\rho = \frac{1}{5f}\left|\frac{E}{H}\right|^2 \qquad (5)$$

3.3 趋肤深度

在无磁性介质中，趋肤深度公式为：$\delta \approx 503\sqrt{\rho/f}$ （米） （6）

由上式可知，电磁波的穿透深度与频率、电阻率有关系，并且随着深度 越深衰减也越厉害，大致对应下表关系。



四、仪器整体介绍

4.1 仪器组成

开关，轻触熄屏，长按开关机

图 4-1：7 寸操控主机

图 4-2：测量主机

图 4-3：MN 电极（左）、不极化电极（右）

图 4-4：电极锤

- **MN 电极**：特制合金电极，可锤、可拔、可插入。
- **不极化电极**：稳定性更优异。
- **电极锤**：可锤、可拔、可作为手持式电极手柄、可踩。

图 4-5：MN 电缆

图4-6：电磁传感器（探棒）

4.2 主要技术参数

4.2.1操控主机参数

参数 型号	ADMT-ZJLY-7
操作显示	7 寸 IPS 高亮触摸屏、横竖屏自动切换
分辨率	800*1280
连接方式	多功能磁吸接头（含充电、USB、信号输入）、Wifi、蓝牙
主要功能	深度可选、实时 2D/3D 绘图
操作系统	Android 8.1
CPU	RK3288 四核 A17
内存	2GB
存储器	16GB
电池	8.4V/6000mAH（可外接手机充电宝）
功耗	6W
充电	5V1A，通用大部分手机充电器
外形尺寸	238*139*53mm
重量	<1 kg
工作环境	-20℃~+60℃，95%RH

图4-7

4.2.2测量主机参数

参数 型号	EH1	EH2	EH4	EH6	EH8
最大深度(m)	≤1000	≤2000	≤4000	≤6000	≤8000
可选深度(m)	10~1000	10~2000	10~4000	10~6000	10~8000
通道模式	MN+TT				
连接方式	WiFi				
频率范围	0.001~2000 Hz				
测量精度	1%Fs				
分辨率	1uV				
选频滤波	预设选频和智能选频、模拟＋数值滤波				
输入阻抗	≥1M				
对 50Hz 工作干扰压制	≥60dB				
采样时间	540~10800s				
外形尺寸	323*275*135mm				
电池	8.4V/7500mAh				
功耗	7.5W				
重量	约 3.5kg				
工作环境	-20℃~+60℃, 95%RH				

图 4-8

4.2.3 MN 电缆

参数 型号	MN 电缆
适配主机	EH 系列主机
电缆节点	2 道/条
搭配电极	MN 电极、不极化电极
电缆道距	20 米
电缆直径	5mm
重量	0.75kg/条

工作环境	-20℃~+60℃，95%RH

图 4-9

4.2.4 电磁传感器（探棒）

该系列仪器的电磁传感器（探棒）是精密器件，适配 EH8、EH6、EH4、EH2、EH1 等型号不同深度的探测需求，一般根据用户注意需要特别定制配置。

五、软件界面功能介绍

5.1 软件主界面

打开操控主机电源后，系统初始化界面屏幕上方菜单显示：系统设置、 文件浏览、用户信息；下方菜单显示：仪器设置、数据处理、绘图分析、新建测量（如图 5-1）。

图 5-1：系统初始化界面

①实时日期和时间。

②系统设置：校准系数的云端下载（需要连接互联网），WIFI 热点和 TCP 服务器的开启等功能。

③文件浏览：查看已经测量的文件，对文件进行查找、备份、删除操作，确认绘图等。

④用户信息：注册或登录“艾都慧测”账号，注册后用户可绑定多台设备，实现数据共享、数据处理、WEB 网页端制图等功能。

⑤电池电量：设备电量和仪器电量交替滚动显示，“SYSTEM：电量百分比”表示当前操控主机的剩余电量，仪器电量在连接上设备后显示，格式为：仪器编号：电量值%。

⑥设备名称型号显示：在初始化连接了设备后会默认显示最后一次连接的设备名称和型号。

⑦仪器设置：设置“滤波方式”、“测点起点”、“测量速度”、“测点增量”、“开始深度”、“结束深度”、“叠加次数”、“EX、EY、HX、HY”。
⑧数据处理。
⑨绘图分析：查看最新测量文件的垂向等值线图、平面等值图、平面曲线图、垂向曲线图。
⑩新建测量：新建一个项目或选择已有项目继续测量。
⑪系统控制栏：从左往右依次是隐藏系统控制栏、调节音量、返回、返回桌面、功能键（查看当前后台运行的程序）、截图键、调节音量。

5.2 系统设置

系统设置界面（图5-2）

图5-2：系统设置

- **参数下载：**下载设备的数据参数，输入框中填入本台仪器的专属编号（请见产品上标注处）（注意：本界面功能必须在连接互联网的情况下才能够从云端服务器下载参数。）
- **蓝牙：**用于开启设备蓝牙功能连接蓝牙设备。
- **WiFi：**用于开启 WiFi 功能连接互联网。
- **语言：**用于切换软件语言。
- **WiFi 热点：**用于开启操控主机的 WiFi 热点功能和 TCP 服务器功能。（注意：操控主机设备的“WiFi”和“WiFi 热点”无法同时打开）
- **移动数据：**移动网络数据设置功能。
- **无线投屏：**将本操控主机设备屏幕投射到其他设备上去。

- **屏幕亮度：**调节操控主机屏幕亮度和熄屏时间。

5.2.1用户信息

如果系统操控主机是自带 4G 版本的，可确认是否打开移动数据；如果是不带 4G 版本的，可先打开 WiFi 连接附近的 WiFi 因特网，返回主界面点击 “用户信息”（如图 5-3）。

图5-3：用户信息

用户登录：初次使用的时候登录“艾都慧测”账号，若没有账号可以使 用手机短信快速注册，登录后您购买的设备编号将与您的账号绑定。

用户退出：退出当前账号。

个人信息：查看当前账号的信息。

扫码登录：使用有摄像头的操控主机扫码登录“艾都慧测”账号。

检查更新：检查软件有无更新版本发布，根据需求选择更新。

5.2.2 用户登录系统登录及注册

已注册艾都慧测账号的用户请按照以下①流程登录；

未注册账号的用户请按照以下②流程先注册再登录。

①：用户信息→用户登录→输入账号和登录密码→点击登录；

②：用户信息→用户登录→立即注册→短信注册→输入手机号→设置登录密码→获取验证码并填入→立即注册→返回登录界面→登录账号。

登录后用户可绑定多个设备，如果未绑定设备也可以使用除仪器设置 新建测量外的其他功能。选择“设备绑定”时同步该仪器特定配置参数，通过账号可以使用数据分

享、数据处理、WEB 网页端制图等等功能，如果不想绑定选择“仅同步仪器数据”能单机完成测量和绘图分析，不能使用账号 可以使用的功能。

序号	功能列表	绑定	未绑定
1	网页后台数据下载、制图、处理等所有功能	√	—
2	数据在账号之间分享	√	—
3	数据云备份（仅备份，不支持下载）	√	√
4	仪器设置	√	√
5	仪器测量	√	√
6	本地绘图	√	√

六、数据测量操作

6.1 WiFi 热点配置

在软件主界面，选择系统设置→WiFi 热点→设置热点→设置 WLAN 热点→网络名称：AiduWT2→安全性：WPA2 PSK→密码：12345678→保存→开启 WLAN 热点  →返回上一级界面→开启服务→完成，连接成 功可能需要 1-3 分钟。

6.2 参数下载

在软件主界面，选择系统设置→参数下载→输入设备编号→点击参数 下载（图 6-1）

图 6-1

6.3 仪器设置

在实际测量的时候首先打开“仪器设置”（图 6-2），设置“开始深度”和“结束深度”等，点击“确认”，会提示设置保存成功！（注：未确认不会保存设置）。

图 6-2

滤波方式：默认选择“下”来滤波；

测点起点：默认“0”，输入范围 0-10000，表示测点增量的起始数字；

测点增量：默认“1”，输入范围±10000，正数是增加，负数是减少；根据测量的下一个点再测点起点数据基础上增减；

叠加次数：默认“6”，可选 4-30 次。

选择 Ex、Ey、Hx、Hy 分别由哪台仪器编号的设备来执行（第一次选择后固定保存，关机不清除）。

6.4 新建测量

点击“新建测量”进入测量界面（图 6-3，星号*为必填项）

图 6-3

新建项目：输入新项目名称或者点击选择加载之前的文件继续测量。 若在测量中途退出需要重新接续上一次的测量，则点击选中项目文件名继 续上一次测线的测量。注意：如果项目名栏中已经有项目名，则需要点击“清空”之后再输入新的项目名称。

第几测线：新建项目起始测量的测线。对于已经存在的项目文件，若设置的测线有数据则从该测线最后一个测点开始测量，若设置的测线没有数 据则新建一条测线开始测量。

测线间距：两条测线之间的间距。（测线编号=第几测线×测线间距，注：不可选择小数点）

清空：如果项目名栏中已经有项目名，点击“清空”之后再新建项目。

确认：设置完以上选项后，点击“确认”进入测量界面（图 6-4）

图 6-4

正式测量前，可进行“检测”是否可以测量数据，无问题即可点击“测量开始勘测（图 6-5）。

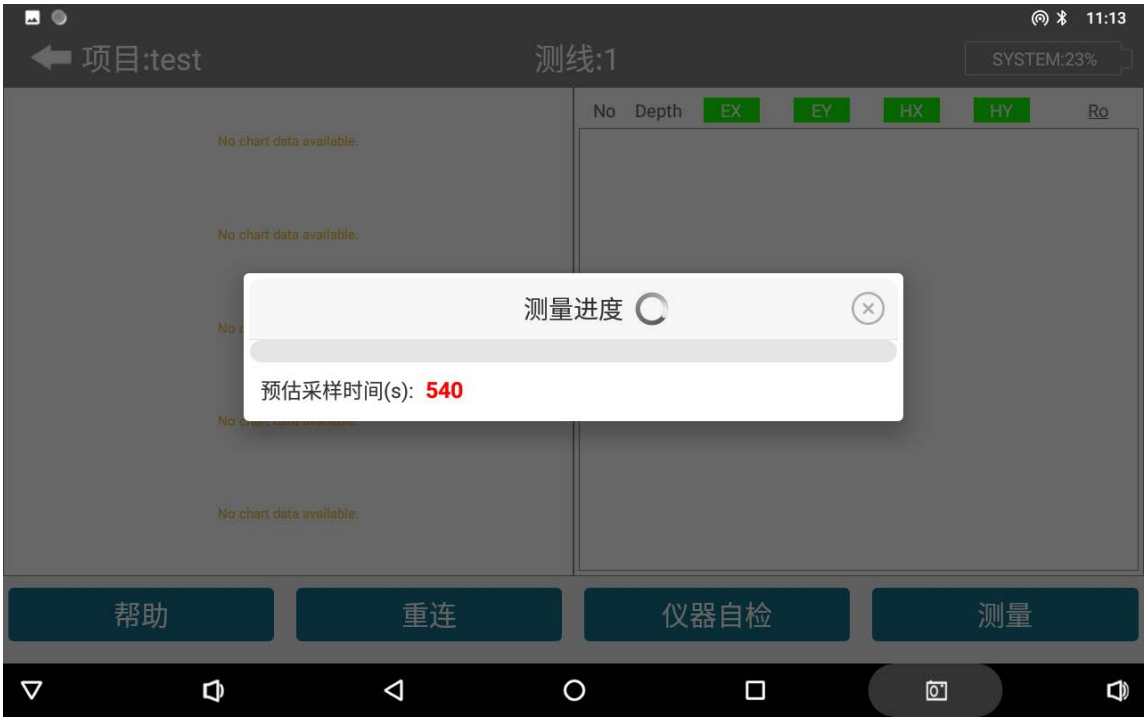


图 6-5

测量过程中如果发现某条进度条归零并显示“重试”，可能是 WIFI 信号出现波动，若需要多次点击“重试”，需检查主界面是否连接断开，同时建议重启测量主机。

七、绘图分析

7.1 绘图功能进入方式

艾都慧测 APP 软件有三个地方可以进入绘图分析功能，第一是在“新建测量”界面读取数据结束后，直接点击“自动绘图”按钮进入绘图分析功能；第二是软件主界面直接点击“绘图分析”按钮进入绘图分析功能；第三是在软件主界面的文件浏览页面，选择某个文件后点击“绘图”按钮进入绘图分析功能。

7.2 垂向剖面图

其中第一、第二种方式进入绘图功能后，会直接显示当前最新文件的“垂向剖面图”（图 7-1），可以通过右上角的“垂向等值线图⇄”来切换“平面曲线图、平面等值线图”等图形，也可以通过左上角数据处理开关来切换显示数据处理前、后的图形。点击“项目”可切换到其他项目文件。

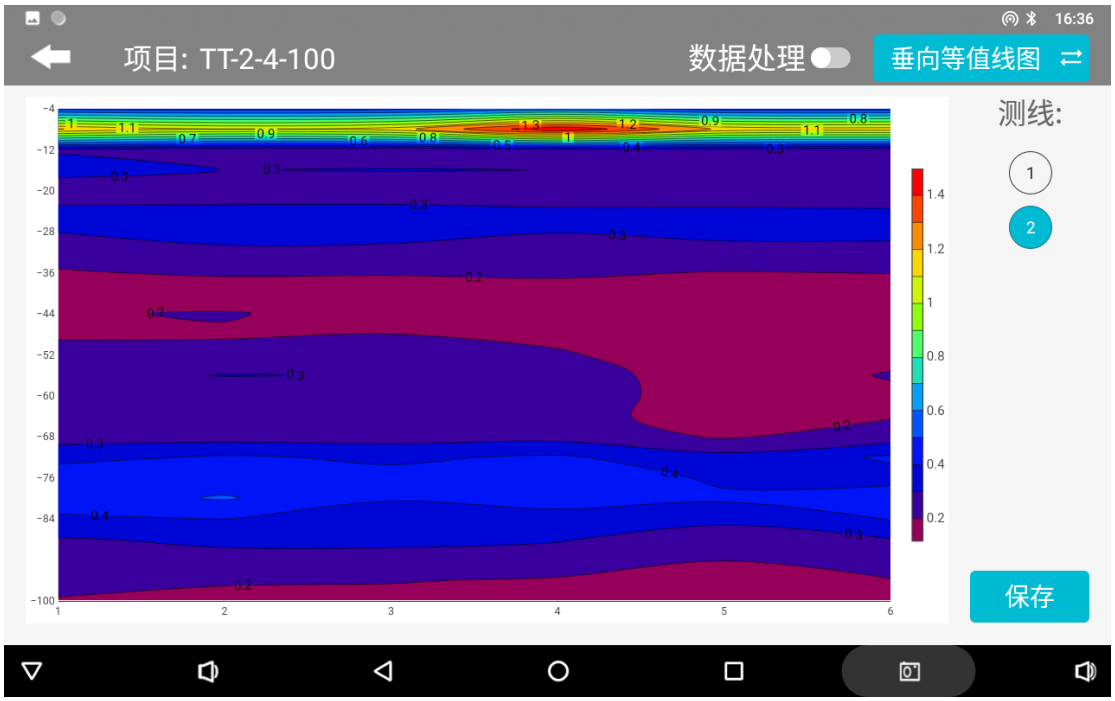


图 7-1

呈现当前项目文件中所有测线的垂向等值线图，在左侧可以选择测线，在等值线图中点击会显示点击处的 XYZ 值（X-测点号，Y-深度，Z-具体数值）。左下角“保存”可以保存当前图像到平板或手机中。需要最少 1 条测线，每条测线上最少 6 个测点才能成图。

7.3 平面曲线图

呈现当前项目文件中所有测线的具体深度数据曲线（图 7-2），左侧可选择该文件下不同深度，左下角“保存”可以保存当前图像。

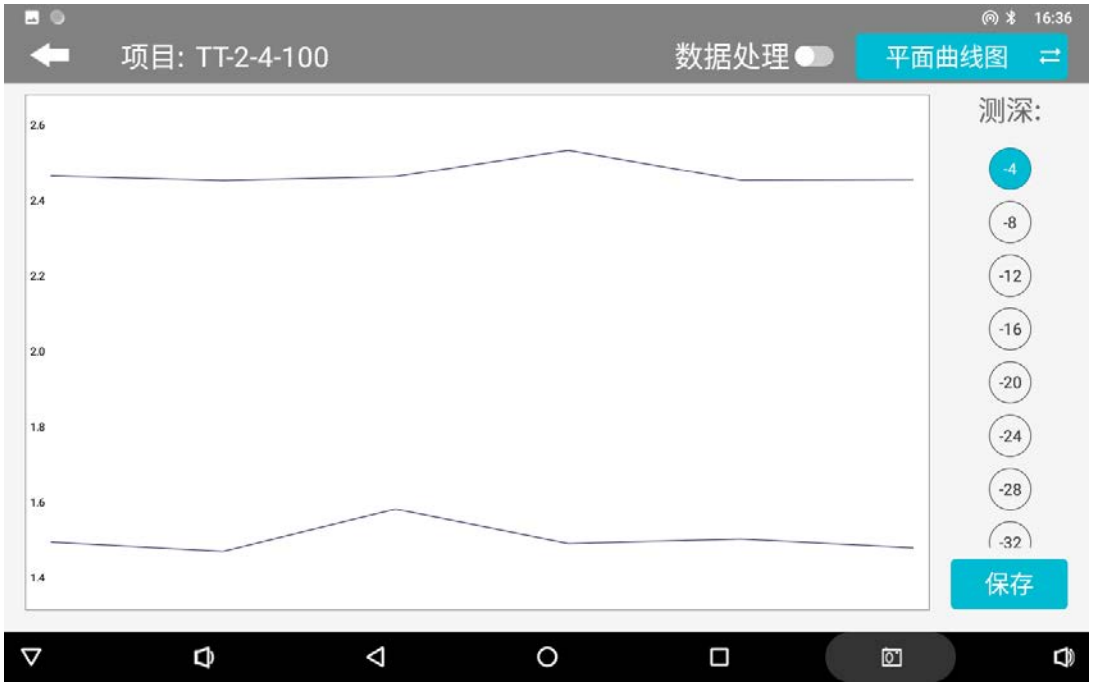


图 7-2

7.4 平面等值线图

呈现当前项目文件中所有测线的平面等值线图（图 7-3），左侧可选择该文件下不同的深度图形，在等值线图中会显示 XYZ 值（X-测点号，Y-测线号，Z-具体数值）。左下角“保存”可以保存当前图像。一般至少需要 2 条测线、每条测线最少 6 个测点才能平面等值线图。

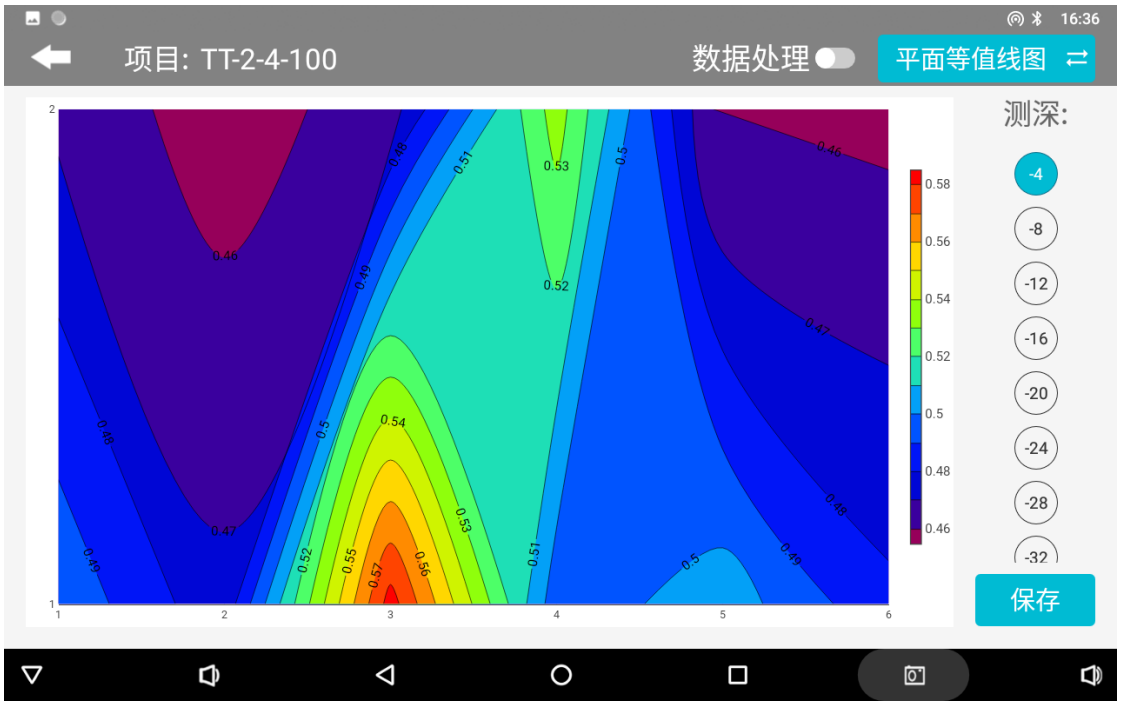
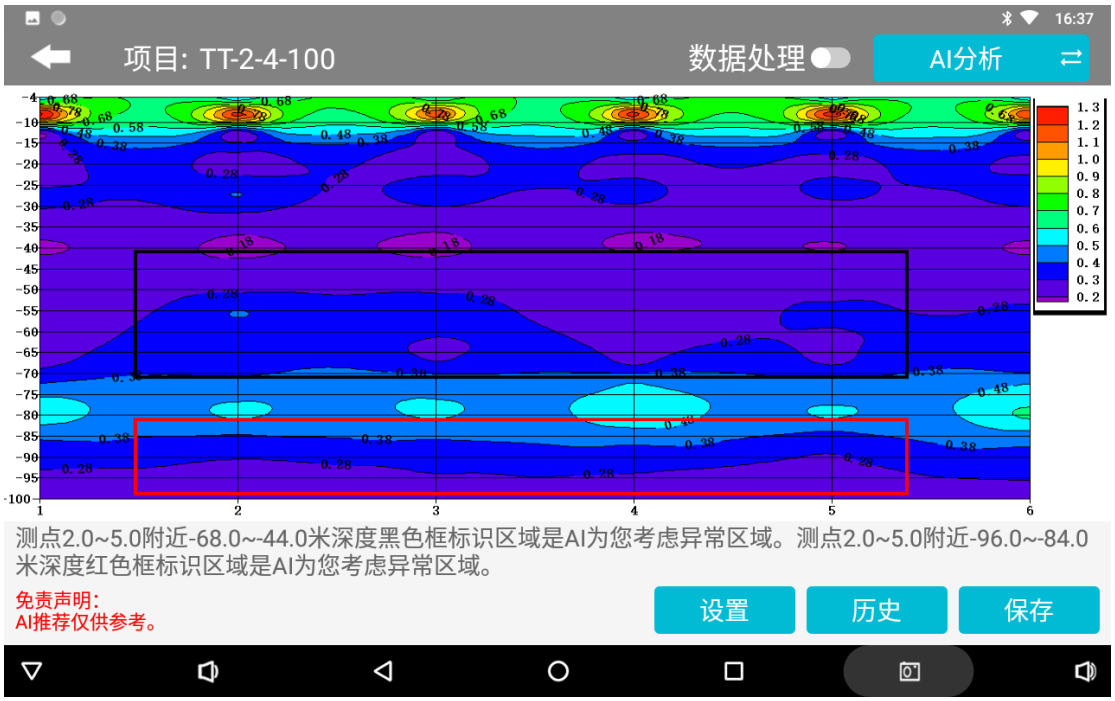


图 7-3

7.5 AI 自动分析

点击“AI 分析”后系统会进入到该文件数据 AI 分析的结果（图 7-4），在底部会提示“测点 xx-xx 附近，深度为 XX-XX 米的黑色（红色）框标识区内为异常区域”等提示，这个异常区一般是仪器设置的常规异常判断，也是指导您打井的位置或深度，一般 AI 会提示 1-2 个区域供您选择，您可结合您的经验和实际水文地质环境做出综合判断，做出决策。

同时，如果您觉得结果不满意，可点击屏幕右下方第一个操作图标可进入 AI 分析设置界面（图 7-5）， 点击“数据下载”可以下载最新的 AI 分析参数，也可点击“参数类型”中可选择“默认”或“AI 推荐”，其中“默认”为公司旗下某型号产品设置的理想分析参数，“AI 推荐”为 AI 分析系统根据用户反馈记录结果来建立数据模型后，AI 自动学习调整生成相关分析参数，原则上这组参数更加贴近真实分析，当然这需要用户自身标记的数据是否准确和标记的数量多寡来决定。



图

图 7-4

图 7-5

也可选择“添加”功能来手动添加属于您这个账户下的 AI 分析参数，我们所有的分析算法已经集中到一个百分比表示，您可手动左右滑动取值范围的百分比来调整 AI 分析的结果，一般百分百越小会显示似电阻率低值区域，百分比越大会显示似电阻率高值区域，也可以是某个中间等，通过对这个百分比的调整来显示到您认为最准确的区域，这样后期 AI 分析时会按照此设置来分析，这样会更准

确。也可以设置标记区域为 1，这样只显示一个最优标记区域。

本 AI 参数设置，一般需要非常熟练的使用本仪器，并且有一定实际使用经验和该型号仪器在当地数据表现为依据来设置，如果初级使用本仪器，暂不建议使用。

选择“删除”会删除该组设置 AI 分析参数。

7.6 记录 AI 分析结果反馈

AI 分析结果反馈是非常重要的，因为 AI 是根据用户反馈来机器学习，建立有效的分配规则，所有 AI 自动分析是“越用越准确、反馈越多越准确”。

在 AI 分析界面点击屏幕右下方第二个操作按钮来找到历史记录界面（图 7-6），选择分析过的数据文件后面的“有效性”栏中的“默认”按钮，如果分析的结果与实际情况一致，则点击“是”（图 7-7），这时系统会记录有效数据，记录越多准确的数据，AI 分析会越来越准确。

不符合则点击“否”，点击“否”后会弹出绘图效果操作框（图 7-9），可通过可手动左右滑动取值范围的百分比范围来调整 AI 分析的结果，一般百分百越小会显示越低值区域，百分比越大会显示越高阻区域，也可以是中间某值，调整分析结果与实际结果一致再标记为有效，这样增加标记有效的数据量，如不调整则不记录。

图 7-6

图 7-7

图 7-8

7.7 保存 AI 分析结果

在 AI 分析界面点击屏幕右下方第三个操作按钮（图 7-9），可以保存 AI 自动分析的图片。

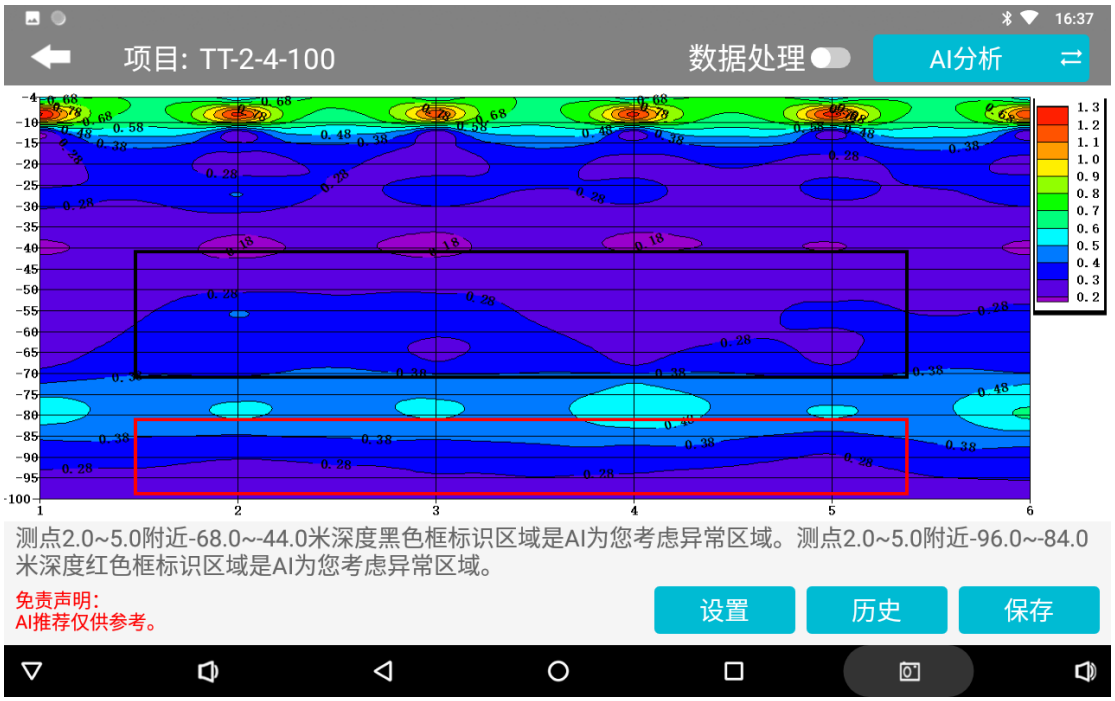


图 7-9

八、仪器野外连接方法

在野外开始布置时，设置好 Ex 和 Ey 通道，用电极锤将 MN 电极打入地下，MN 电极之间的距离约 20 米，一般埋设 Hx 和 Hy 电磁传感器（探棒）至地下 20-100cm 水平放置（图 8-1）。

图 8-1

野外使用时，可以设置东-西或南-北为 X 方向，那么南-北或东-西就是 Y 方向（如图 8-2、图 8-3）。在将电极和测线连接后，最后将测线和电磁传感器接口接入测量主机中（图 8-4）。

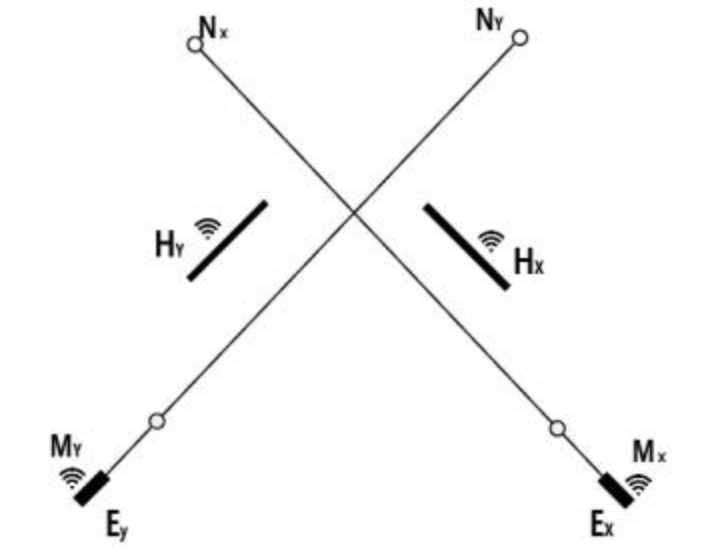


图8-2：野外布置示意图

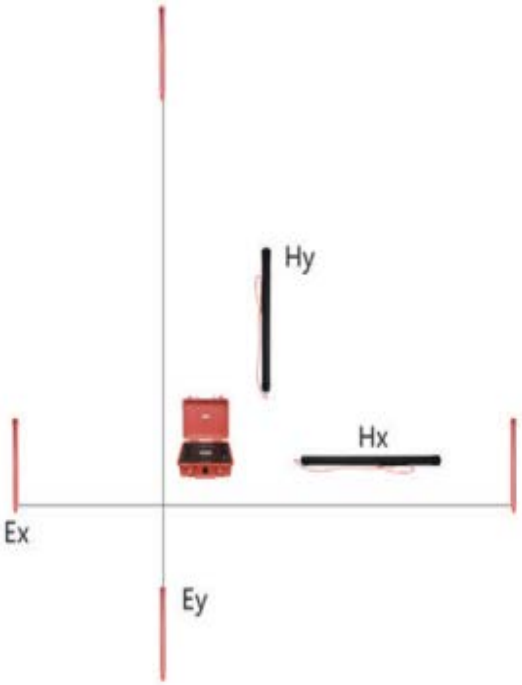


图8-3：野外布置示意图2

图 8-4

九、使用仪器的注意事项

1. 请定期检查设备电池电量，定期充电。工作时间保持电量充足，工作结束后及时关闭电源。
2. 设备在运输或使用过程中要有专人保管，避免仪器受剧烈震动、撞击和进水受潮。
3. 每次工作结束后，保持设备干净，放置在通风干燥处。
4. 设备测量中遇到每个测点的测量数据都偏小且数值基本一致时，可能是仪器故障，请联系售后确认。

注意：本产品说明书内定义的产品操作可能会随公司产品优化改进而有所变动，如有变动以我司最新电子版为准。

Scope of Application

The models of the ADMT series of electromagnetic conductivity meters to which this user manual applies are: EH8, EH6, EH4, EH2, EH1.

User Instructions

Thank you for choosing the Geomagnetic Conductivity Meter equipment (hereinafter referred to as the "equipment") produced by Shanghai Aidu Intelligent Detection Technology Co., Ltd. Before using this product, please read this product manual carefully. This manual contains important information and data regarding the use of the product. Users must strictly follow the regulations outlined in this manual to ensure the proper operation of the equipment.

Manual Summary

This manual provides detailed instructions on operating and maintaining the equipment. It also explains the measurement principles, instrument components, and performance characteristics of the equipment. It serves as an accurate reference for technical personnel who have received specialized training or possess knowledge of instrument operation and control, such as automation technology.

Chapter	Contents
1. Measurement System Overview	To elaborate on the basic information of the instrument
2. Main Features of the Instrument	Key Technical Features of the Instrument
3. Introduction to the Operating Principle of the Instrument	Principle of Operation of the Instrument
4. Introduction and Technical Specifications of the Instrument	Components and Specifications of the Instrument
5. Introduction of the Software Interface Functions	Interface Functions and How to Log in and Register
6. Data Measurement Operations	Measurement Steps for the Instrument
7.Drawing operations methods	How to use data for plotting
8.Instrument field connection methods	Instrument Field Connection Methods
9.Precautions for Using Instruments	Precautions for Instrument Usage

1. Instrument Overview

The ADMT series of instruments for measuring electrical conductivity in the ground consists of five models: EH8, EH6, EH4, EH2, and EH1. These instruments are specifically designed for special magnetotelluric (MT) measurements at depths of 8000, 6000, 4000, 2000, and 1000 meters underground, respectively. They can measure both natural electromagnetic signals in the frequency range of 0.001 to 2 kHz and artificially induced electromagnetic signals to obtain the electrical structure beneath the measurement point.

The EH8, EH6, EH4, EH2, and EH1 electromagnetic conductivity measurement systems measure the resistivity at different depths underground by simultaneously measuring the electric fields Ex and Ey and the electromagnetic fields Hx and Hy at different

frequencies. The electric fields at different frequencies are captured through MN electrodes, while the electromagnetic fields at different frequencies are captured through high-precision magnetic rods and pre-amplification circuits. After undergoing Fourier transformation, smoothing filtering, median correction, and other data processing techniques, the resistivity data for the measurement point is obtained.

Although field measurements may take several minutes to several tens of minutes, the obtained resistivity data can provide a reasonably accurate estimate of the underground electrical layering at the measurement point.

The ADMT series measurement systems, including EH8, EH6, EH4, EH2, and EH1, consist of a receiver control host, Ex and Ey electric field measurement host, Hx and Hy electromagnetic field measurement host, electromagnetic sensors (probes), MN electrodes, and other accessories. These systems feature wireless connectivity via Wi-Fi and are designed to be waterproof. In some special applications, a transmitter can be added to improve data quality, especially in high-frequency bands where natural signals are typically weak.

The EH8, EH6, EH4, EH2, and EH1 electromagnetic conductivity measurement systems are capable of adjusting their configuration parameters automatically within the maximum depth range set by the system. This allows for selecting the desired exploration depth as per the requirements. These instruments are widely used in the survey and detailed investigation of groundwater, geothermal springs, metal minerals, oil and natural gas resources, as well as in engineering geophysics and geological hazard investigations. They offer advantages such as wireless connectivity, simple operation, real-time automatic mapping and analysis, and timely cloud backup of data. They also provide remote downloading, mapping, and analysis capabilities, along with real-time monitoring of data acquisition quality.

The core technology of the EH8, EH6, EH4, EH2, and EH1 electromagnetic conductivity measurement systems has obtained multiple invention patents (Patent Numbers: 201310205318.9, 201320054153.5, 201120214308.8, 201320303919.9).

They have been recognized as Shanghai High-tech Technology Achievement Transformation Projects. Over the past twenty years, extensive practical applications have demonstrated excellent consistency in anomaly curves compared to DC resistivity instruments within a depth of 1000 meters. Compared to similar imported products in the industry, these systems have significantly improved stability, reliability, and anti-interference capabilities, while significantly enhancing intelligence and simplicity. They have gained recognition and support from a wide range of customers.

2. Main Features

1) Real-time automatic mapping and analysis: The system integrates data acquisition, processing, and mapping capabilities, allowing for on-site real-time generation of depth profile curves, cross-sectional maps, and contour maps. The system provides instant analysis results and enables monitoring of data acquisition quality.

2)Intelligent and easy-to-use: The system optimizes instrument parameter settings, data

acquisition, and processing, all of which are done intelligently. It offers a simple setup process, and after measurement, it provides effective data and images.

3)Adjustable depth: The measurement system allows for selecting the desired depth within the maximum depth range of the specific model.

4)Data sharing: The system enables data sharing between remote locations and on-site operations through various terminal devices such as smartphones, control hosts, and PC hosts.

3. Instrument Working Principle Overview

The EH8, EH6, EH4, EH2, EH1, and other electromagnetic conductivity measurement systems utilize the magnetotelluric (MT) method, which utilizes the Earth's natural electromagnetic field as the working field source. This method is used to study the electrical structure of the Earth's interior. It is based on the principle that electromagnetic waves of different frequencies have different skin depths in conductive media.

By measuring the Earth's electromagnetic response sequence from high-frequency to low-frequency at the surface, the system analyzes the variations in electrical properties of geological bodies at different depths underground. This enables the determination of the occurrence status of subsurface geological bodies. The different skin depths associated with different frequencies provide insights into the electrical properties of subsurface geological structures.

3.1 Helmholtz equation

The Helmholtz equation is a partial differential equation commonly used in various fields, including electromagnetics. It describes the propagation of electromagnetic waves in a medium and is derived from the Maxwell's equations.

If we assume that the majority of the subsurface medium is non-magnetic and macroscopically homogeneous and conducting, with no charge accumulation, the Maxwell's equations can be simplified as follows:

$$\left.\begin{aligned}\nabla^2 H + k^2 H = 0\\ \nabla^2 E + k^2 E = 0\end{aligned}\right\} \qquad (1)$$

Here, K represents the wave number (or propagation coefficient).

$$k = [\omega^2 \mu\varepsilon - i\omega\sigma\mu]^{\frac{1}{2}} \qquad (2)$$

Considering that the propagation coefficient K is a complex number, let K = b + ia, where 'a' is the phase coefficient and 'b' is the absorption coefficient. The different models of EH8, EH6, EH4, EH2, EH1 are designed based on the maximum depth setting and the frequency response range of the electromagnetic sensors (probes).

They incorporate reasonable adjustments to the instrument's amplification circuit, filtering, smoothing, and other data processing methods. The frequency range and core frequency points are optimized differently in various regions. The frequency range typically spans from 0.001 Hz to 2 kHz.

3.2 Wavegroup impedance and resistivity

In the presence of a changing magnetic field induced by variations in the Helmholtz equation, there is a relationship between electric field and magnetic field, given by:

$$\frac{E}{H} = -\frac{i\omega\rho}{k} \qquad (3)$$

Surface impedance Z is defined as the ratio of the horizontal components of the electric field and magnetic field at the Earth's surface. In the case of a homogeneous Earth, this impedance is independent of the polarization of the incident field and depends on the electrical resistivity and the frequency of the electromagnetic field:

$$Z = \frac{E}{H} = \sqrt{\omega\mu\rho}e^{i\pi/4} \qquad (4)$$

Equation (4) can be used to determine the resistivity of the Earth:

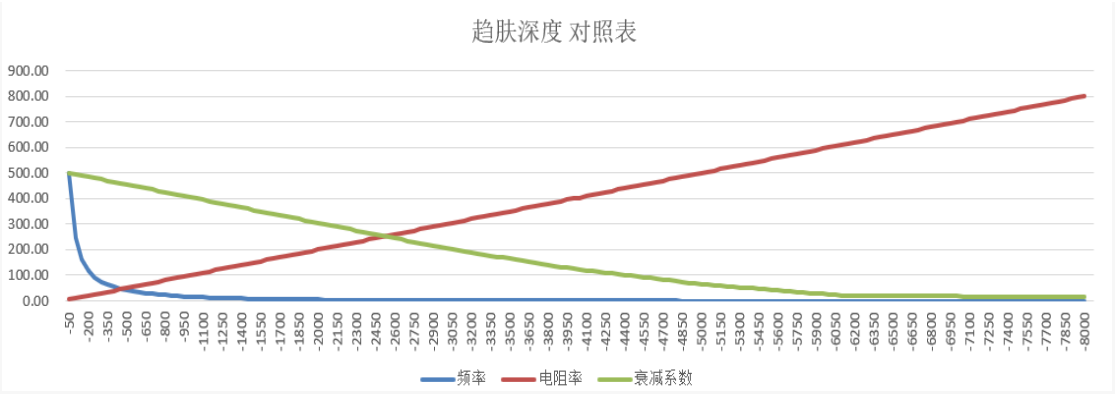
$$\rho = \frac{1}{5f}\left|\frac{E}{H}\right|^2 \qquad (5)$$

3.3 Skin Depth

In a non-magnetic medium, the formula for skin depth is given as:

$$\delta \approx 503\sqrt{\rho/f} \quad (m) \qquad (6)$$

From the above equation, it can be observed that the penetration depth of electromagnetic waves is influenced by frequency and resistivity. Moreover, as the depth increases, the attenuation becomes more significant. The approximate corresponding relationships are summarized in the table below.



Skin Depth Comparison Chart

4. Instrument Description and Technical Specifications

4.1 Instrument Components

Figure 4-1: 7-inch Control host

Figure 4-2: Measurement host

Figure 4-3: MN Electrode

Figure 4-3: Non-polarizing Electrode

MN Electrode: Specially designed alloy electrode, can be hammered, detached, and inserted.
Non-polarizing Electrode: Offers superior stability.

Figure 4-4: Electrode Hammer

Figure 4-5: MN Cable

Figure 4-6: Electromagnetic Sensor (Probe)

4.2 Main Technical

4.2.1 Control Console Parameters

Model Parameter	ADMT-ZJLY-7
Display screen	**7-inch IPS highlight touch screen, automatic switching between horizontal and vertical screens**
Resolution	**800*1280**
Connection Method	**Multi-functional magnetic suction connector (including charging, USB, signal input), WiFi, Bluetooth**
Main Function	**Optional depth and real-time 2D/3D mapping**
Operating System	**Android 8.1**
CPU	**RK3288 quad-core A17**
Memory	**2GB**
Storage	**16GB**
Battery	**8.4V/6000mAH (can be connected to an external mobile power bank)**
Power Consumption	**6W**

Charging	**5V1A, compatible with most mobile phone chargers**
Size	**238*139*53mm**
Weight	**<1 kg**
Working Environment	**-20℃～+60℃，95％RH**

4.2.2 Measurement Host Parameters

Parameter \ Model	EH1	EH2	EH4	EH6	EH8
Maximum Depth(m)	**≤1000**	**≤2000**	**≤4000**	**≤6000**	**≤8000**
Selectable Depth(m)	**10~1000**	**10~2000**	**10~4000**	**10~6000**	**10~8000**
Channel Mode	**MN+TT**				
Connection Method	**WiFi**				
Frequency Range	**0.001~2000 Hz**				
Measurement Accuracy	**1%Fs**				
Resolution	**1uV**				
Frequency-selective filter	**Pre-set frequency and intelligent frequency selection, analog + digital filtering**				
Input impedance	**≥1M**				
Suppression of 50Hz working interference	**≥60dB**				

Sampling Time	**540~10800s**
Size	**323*275*135mm**
Battery	**8.4V/7500mAh**
Power Consumption	**7.5W**
Weight	**Approximately 3.5kg**
Working Environment	**-20℃～+60℃，95％RH**

4.2.3 MN Cable Parameters

Model Parameter	MN Cable
Adapter Host	EH series host
Cable Node	2 channels/lines
Matching electrodes	MN electrode, Non-polarizing electrode
Cable spacing	20 meters
cable diameter	5mm
Weight	0.75kg/piece
Working environment	-20℃ ~ +60℃，95％RH

4.2.4 Electromagnetic Sensor (Probe)

The electromagnetic sensor (probe) of this instrument series is a precision device designed to accommodate different detection requirements at various depths, such as EH8, EH6, EH4, EH2, EH1, etc. Custom configurations are typically available based on specific user needs.

5. Software Interface Functions' Introduction

5.1 Software Main Interface

After powering on the control console, the system initialization interface displays the

following menus at the top of the screen: System Settings, File Browser, User Information. At the bottom of the screen, the menus are displayed as: Instrument Settings, Data Processing, Plot Analysis, New Measurement (as shown in Figure 5-1).

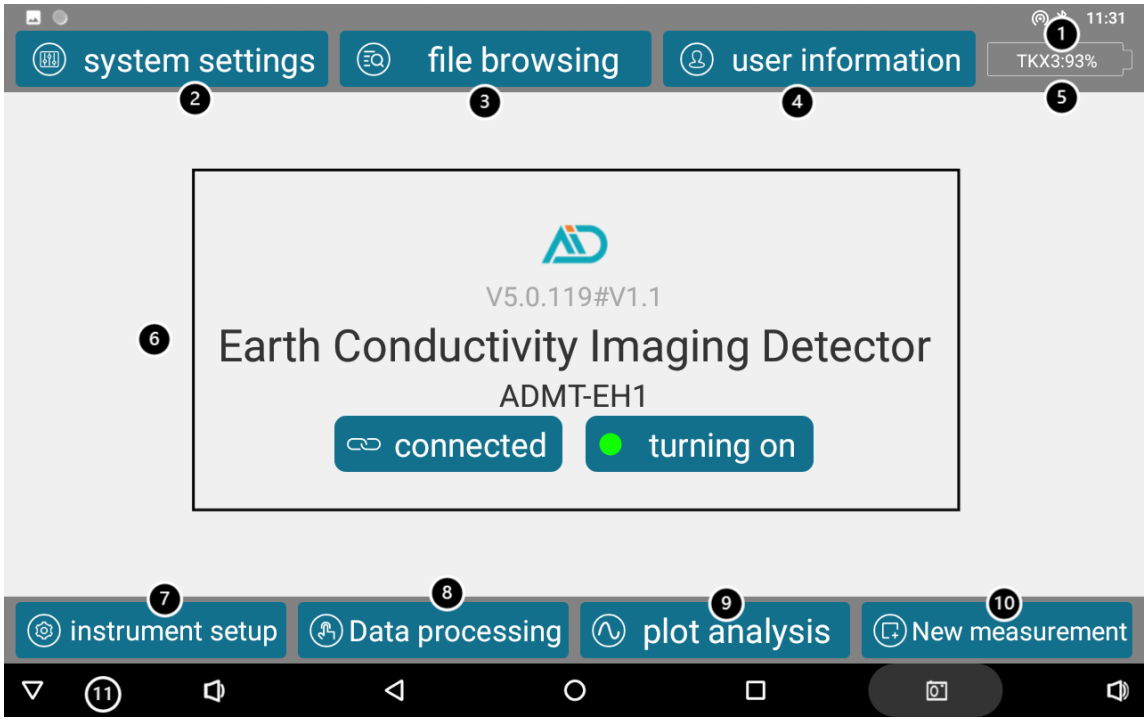


Figure 5-1: System Initialization Interface

① Real-time Date and Time.

② System Settings: Functions include cloud-based download of calibration coefficients (requires internet connection), enabling Wi-Fi hotspot and TCP server, etc.

③ File Browser: View previously measured files, perform operations such as searching, backing up, deleting files, and confirming plots.

④ User Information: Register or log in to the "Aidu Detection" account. After registration, users can bind multiple devices for data sharing, data processing, and web-based mapping functions.

⑤ Battery Level: The device and instrument battery levels are alternately displayed. "SYSTEM: Battery Percentage" indicates the remaining power of the control console, and the instrument battery level is displayed after connecting to the device in the format: Instrument ID: Battery Value%.

⑥ Device Name and Model Display: After initializing and connecting a device, the last connected device's name and model will be displayed by default.

⑦ Instrument Settings: Configure "Filtering Method," "Measurement Starting Point," "Measurement Speed," "Measurement Increment," "Start Depth," "End Depth," "Overlay Count," "EX, EY, HX, HY."

⑧ Data Processing.

⑨ Plot Analysis: View vertical contour plots, planar contour plots, planar curve plots, and vertical curve plots of the latest measured file.

⑩ New Measurement: Create a new project or continue measuring in an existing project.

⑪ System Control Bar: From left to right, the functions of the buttons are as follows:

Hide System Control Bar
Adjust Volume
Back
Return to Desktop
Function Key (View Currently Running Programs)
Screenshot
Adjust Volume

5.2 System Settings

System Settings Interface (Figure 5-2)

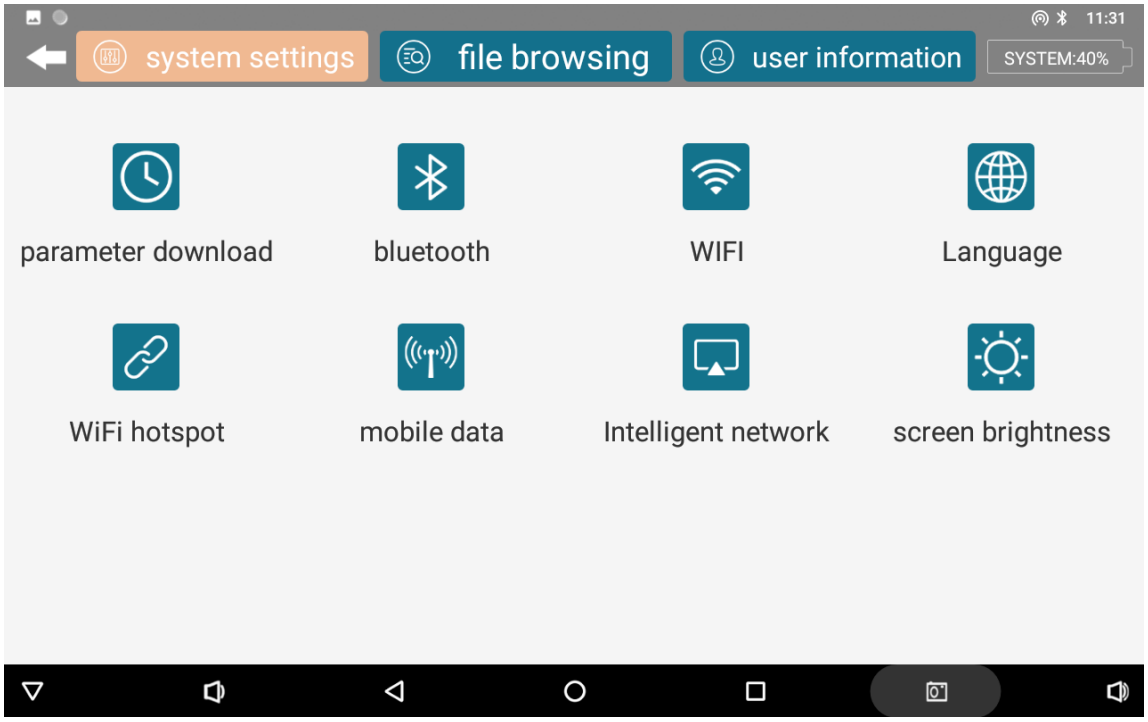


Figure 5-2: System Settings

- Parameter Download: Download data parameters for the device. Fill in the input box with the unique identifier of this instrument (as indicated on the product). Note: This function in the interface requires an internet connection to download parameters from the cloud server.
- Bluetooth: Used to enable the device's Bluetooth function and connect to Bluetooth devices.
- WiFi: Used to enable the WiFi function and connect to the internet.
- Language: Used to switch the software language.
- WiFi Hotspot: Used to enable the WiFi hotspot function and TCP server function of the control console. Note: The "WiFi" and "WiFi Hotspot" of the control console cannot be enabled simultaneously.
- Mobile Data: Mobile network data settings function.
- Wireless Display: Mirrors the screen of the control console onto other devices.
- Screen Brightness: Adjusts the screen brightness and screen-off time of the control console.

5.2.1 User Information

If the control console has a built-in 4G version, you can confirm whether the mobile data is turned on. If it does not have a 4G version, you can first connect to a nearby WiFi internet, then go back to the main interface and click "User Information" (as shown in Figure 5-3).

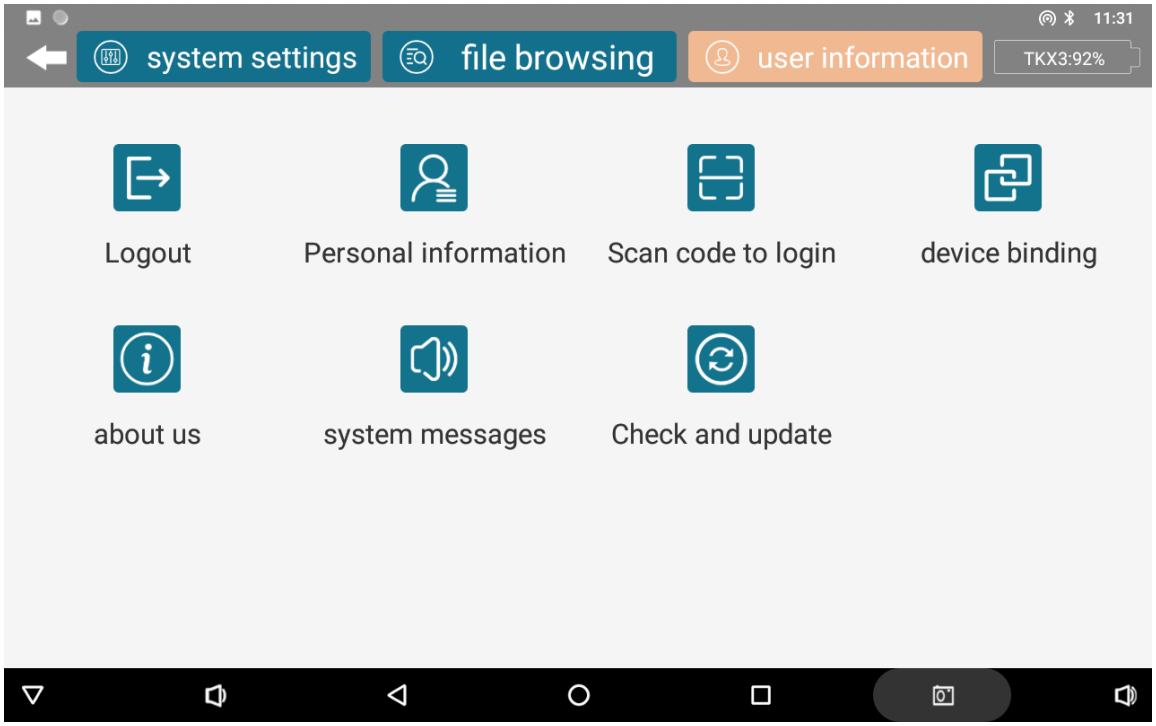


Figure 5-3: User Information

User Login: Login to the "Aidu Detection" account when using it for the first time. If you don't have an account, you can quickly register using your mobile phone number. After logging in, the device ID you purchased will be linked to your account.
User Logout: Log out of the current account.
Personal Information: View the information associated with the current account.
Scan Code Login: Use a control console with a camera to scan and log in to the "Aidu Detection" account.
Check for Updates: Check if there are any new software updates available and choose to update as per your requirement.

5.2.2 User Login and Registration System

For users who have already registered an Aidu Detection account, please follow the following steps (①) to log in.

For users who haven't registered an account, please follow the following steps (②) to register and then log in.

①: User Information → User Login → Enter account and login password → Click on Login.

②: User Information → User Login → Register Now → SMS Registration →

Enter mobile phone number → Set login password → Receive verification code and fill it in → Register Now → Return to login interface → Login with the account.
After logging in, users can bind multiple devices. Even if a device is not bound, they can still use other functions except for instrument settings and creating new measurements. When selecting "Device Binding," specific configuration parameters of the instrument will be synchronized. Through the account, users can access various functions such as data sharing, data processing, and web-based mapping. If you prefer not to bind, selecting "Only Synchronize Instrument Data" allows you to conduct measurements and perform plot analysis locally, without using the account-based features.

No	Function	Bindin	Not
1	Web Backend Data Download, Plotting, Processing, and All Other Functions	√	
2	Sharing data between accounts	√	
3	Cloud Backup of Data (Backup only, no download support)	√	√

4	Instrument Settings	√	√
5	Instrument Measure	√	√
6	Local Drawing	√	√

6. Data Measurement Operations

6.1 WiFi Hotspot Configuration

In the software main interface, select System Settings → WiFi Hotspot → Set Hotspot → Set WLAN Hotspot → Network Name: AiduWT → Security: WPA2 PSK → Password: 12345678 → Save → Enable WLAN Hotspot → Go back to the previous interface → Enable Service → Complete. It may take 1-3 minutes for the connection to be successful.

6.2 Parameter Download

On the software main interface, select System Settings → Parameter Download → Enter Device ID → Click on Parameter Download (Figure 6-1).

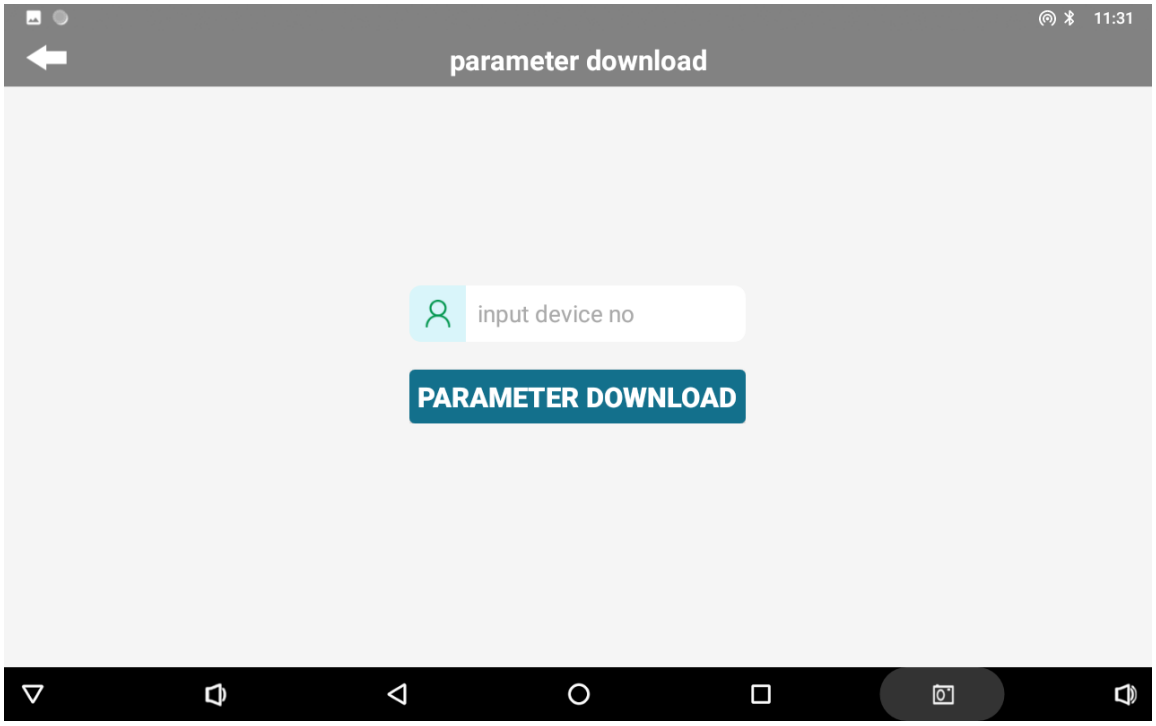


Figure 6-1

6.3 Instrument Setting

During actual measurement, start by opening "Instrument Settings" (Figure 6-2), where you can configure parameters such as "Start Depth" and "End Depth." After making the necessary adjustments, click on "Confirm," and a prompt will appear indicating that the

settings have been successfully saved. Please note that settings will not be saved unless confirmed.

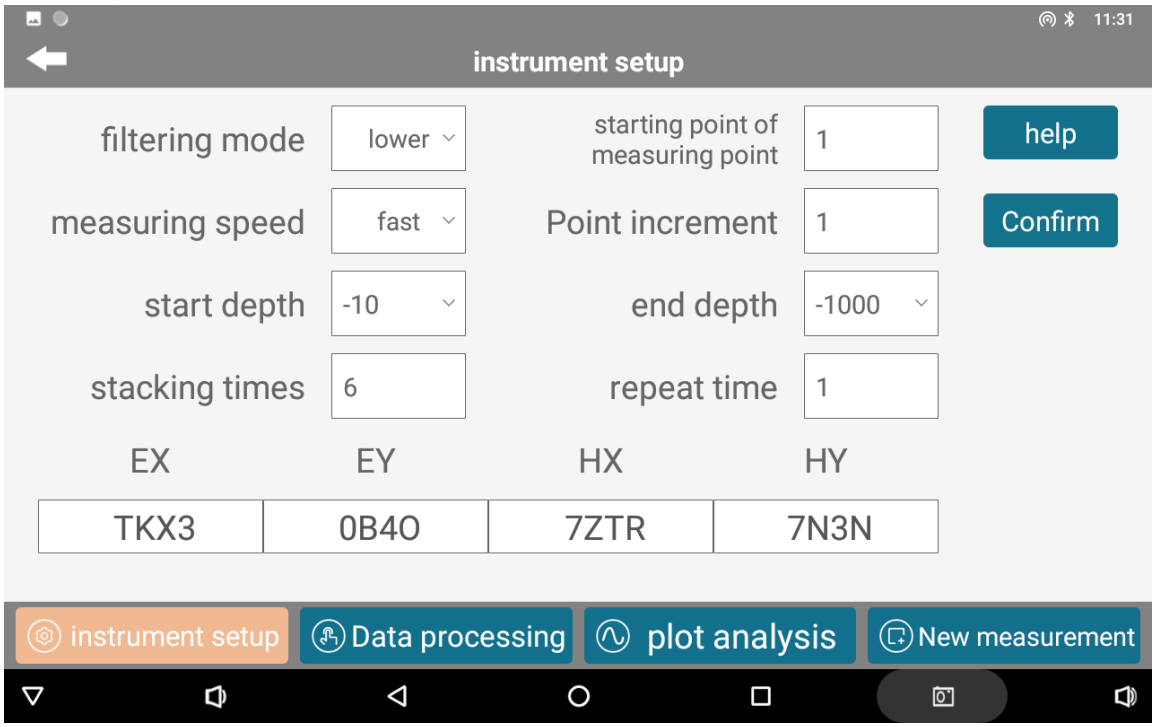


Figure 6-2

- Filter Mode: The default selection is "Down" for filtering.
- Measurement Start Point: The default is "0," with an input range of 0-10000, representing the starting number for the measurement point increment.
- Measurement Point Increment: The default is "1," with an input range of ±10000. Positive values increase the increment, while negative values decrease it. The next measurement point is based on the current measurement point increment.
- Overlay Times: The default is "6," with options ranging from 4 to 30 times.
- The selection of which device's equipment executes Ex, Ey, Hx, and Hy is fixed and saved after the initial selection. The settings are retained even after shutting down the system.

6.4 Create new measurement

- To create a new measurement, click on "New Measurement" to enter the measurement interface (Figure 6-3). Fields marked with an asterisk (*) are required.

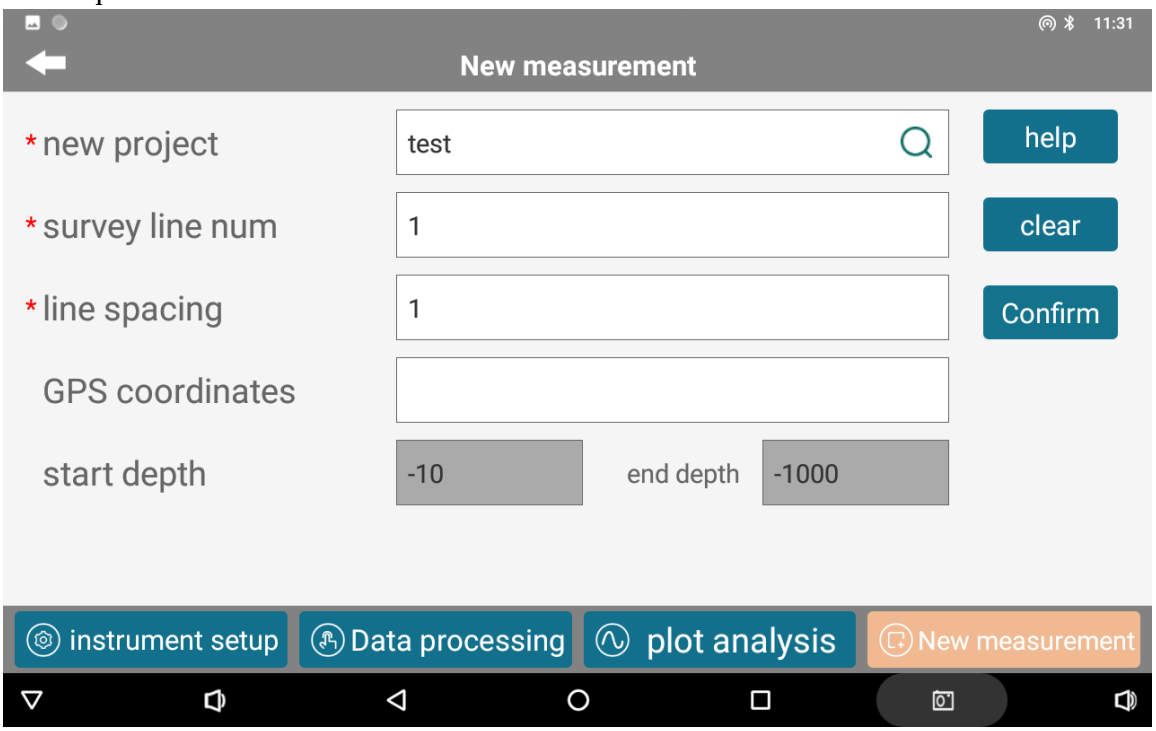


Figure 6-3

- New Project: Enter a new project name or click to select and load a previously saved file for continuation of the measurement. If you need to resume the previous measurement after exiting in the middle of the measurement, select the project file name to continue the measurement. Note: If there is already a project name in the project name field, you need to click on "Clear" before entering a new project name.
- Line Number: It represents the initial measurement line for a new project. For existing project files, if there is data available for the set measurement line, the measurement will start from the last data point of that line. If there is no data available for the set measurement line, a new measurement line will be created and the measurement will start from there.
- Line Spacing: It refers to the distance between two measurement lines. (Line Number = Line Spacing × Measurement Line Number; note: decimal values cannot be selected.)
- Clear: If there is already a project name in the project name field, click on "Clear" before creating a new project.
- Confirm: After setting the above options, click on "Confirm" to enter the measurement interface (Figure 6-4).

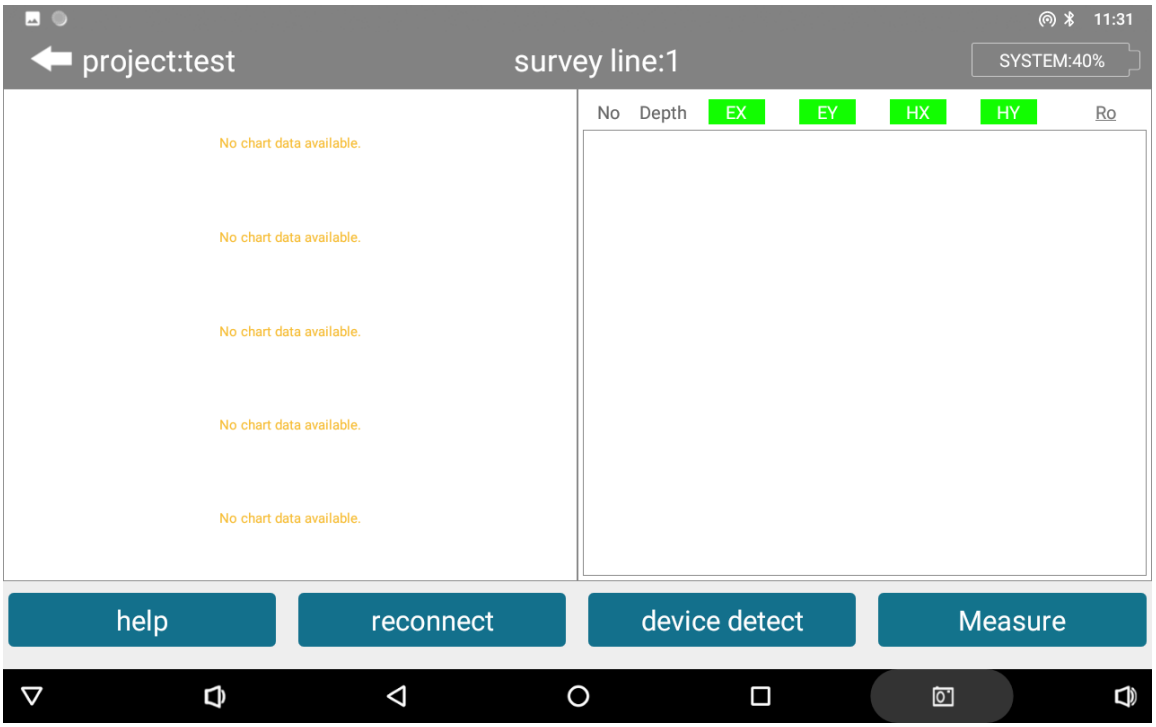


Figure 6-4

Before initiating the actual measurement, you can perform a "Check" to verify if the measurement data can be obtained. If there are no issues, click on "Measure" to start the survey (Figure 6-5).

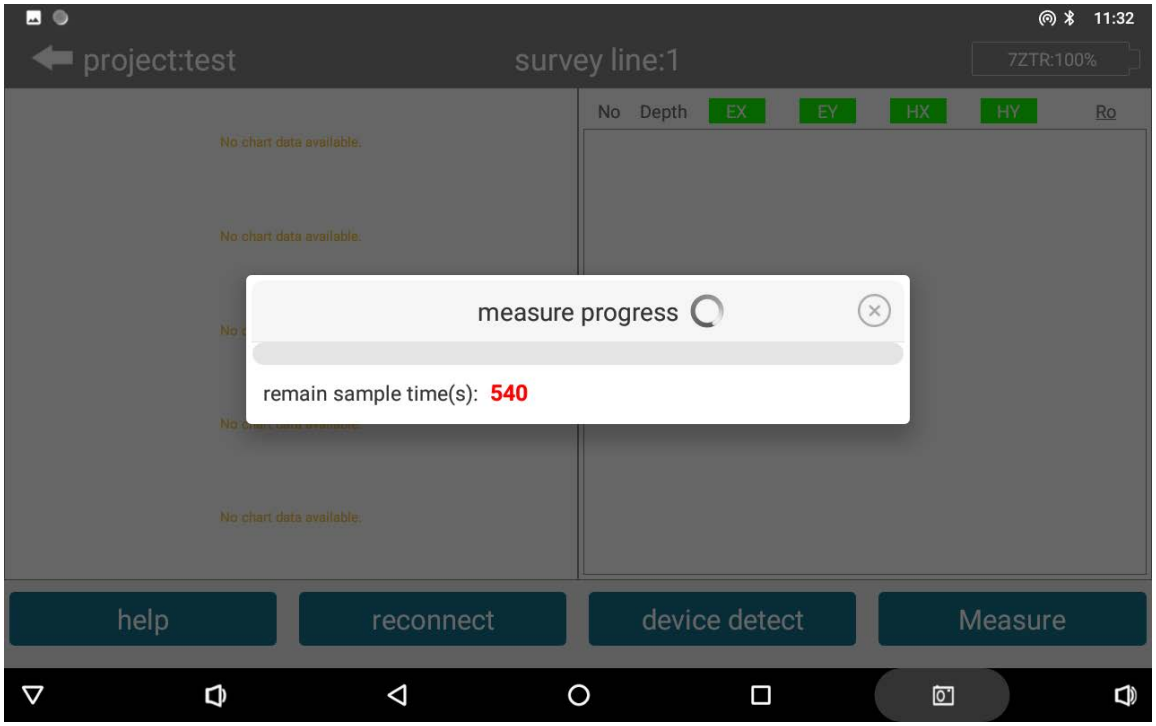


Figure 6-5

If during the measurement process you encounter a progress bar resetting to zero and displaying "Retry," it could indicate fluctuations in the WiFi signal. If you need to click

"Retry" multiple times, check if the connection is disrupted on the main interface. It is also recommended to restart the measurement host.

7. Plotting Operations

7.1 Entry mode of drawing function

There are three places to enter the drawing analysis function in Aidu detection APP. The first is to directly click the "auto draw" button to enter the drawing analysis function after reading the data in the "New Measurement" interface. The second is to directly click the "Drawing Analysis" button in the main interface of the software to enter the drawing analysis function. Third, on the file browsing page of the main interface of the software, select a file and click the "Drawing" button to enter the drawing analysis function.

7.2 vertical contour map

After entering the drawing function in the first and second modes, the "vertical contour map" (Figure 7-1) of the current latest file will be directly displayed. The "vertical contour map" in the upper right corner can be used to switch the "plane curve map, plane contour map" and other graphics, and the data processing switch in the upper left corner can also be used to switch the graphics before and after data processing. Tap Project to switch to a different project file.

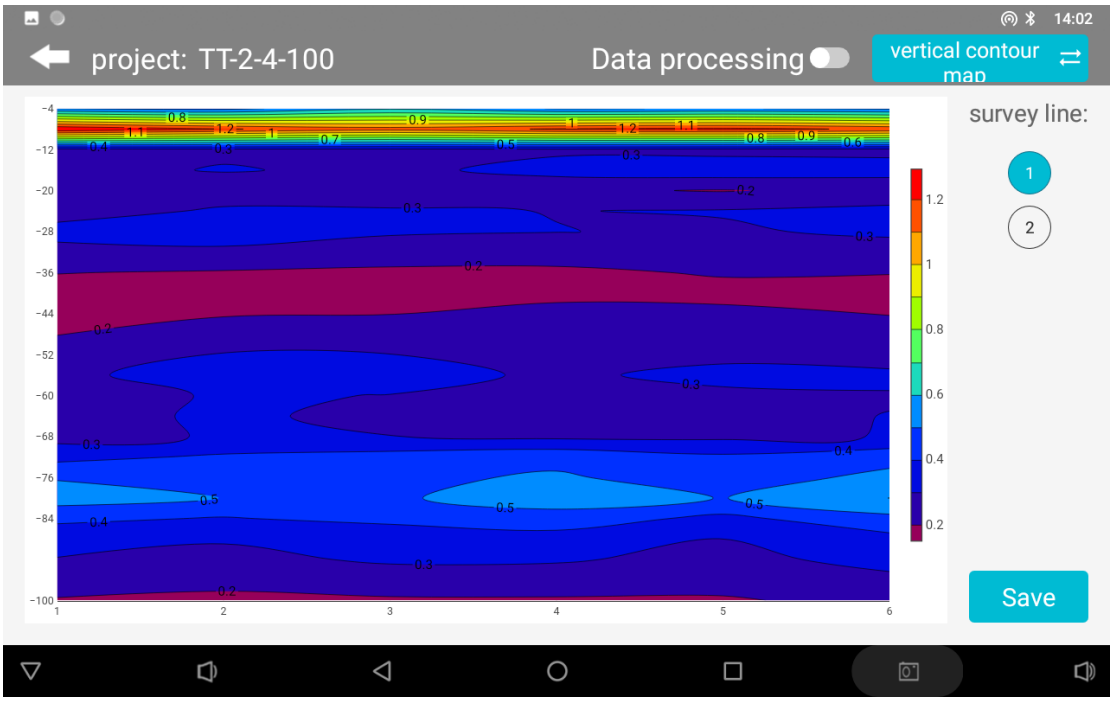


Figure 7-1

The vertical contour map of all survey lines in the current project file is displayed. You

can select the survey line on the left side. Click in the contour map to display the XYZ value at the clicked position (X-survey point number, Y-depth, Z-specific value). "Save" in the lower left corner can save the current image to the tablet or mobile phone. A minimum of one survey line is required, and a minimum of six survey points on each survey line are required for mapping.

7.3 Plane curve diagram

The specific depth data curve of all survey lines in the current project file is displayed (Figure 7-2). Different depths in the file can be selected on the left, and the current image can be saved by "Save" in the lower left corner.

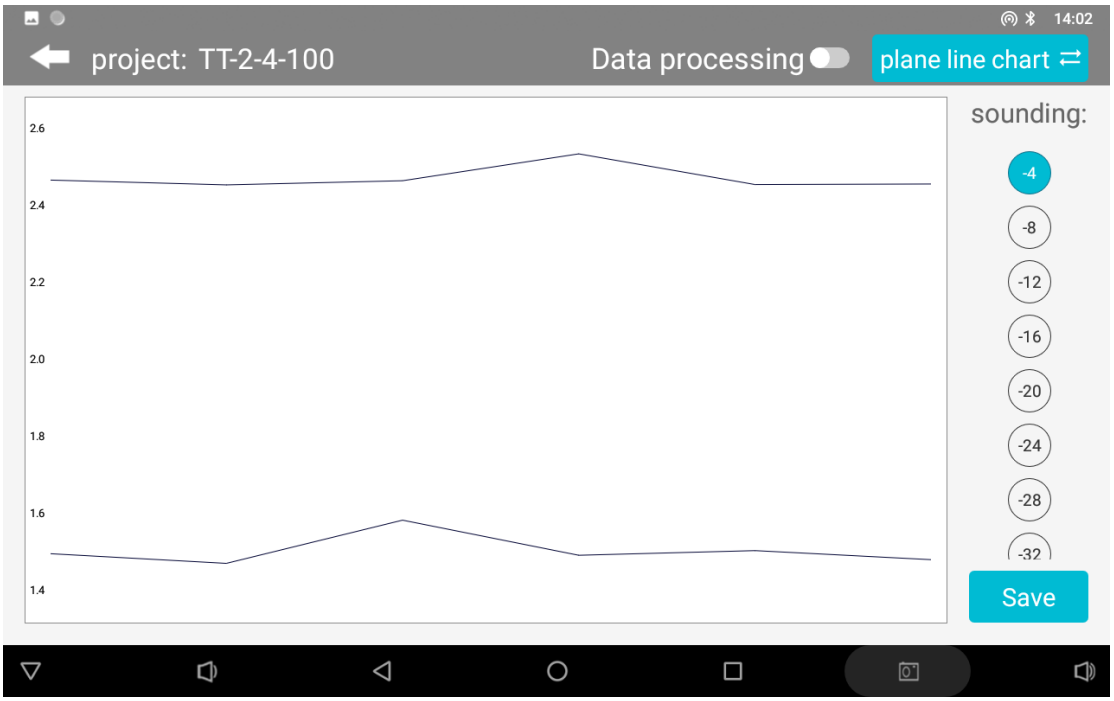


Figure 7-2

7.4 Plane contour map

The plane contour map (Figure 7-3) of all survey lines in the current project file is displayed. On the left side, you can select different depth maps under the file. XYZ values (X-survey point number, Y-survey line number, Z-specific value) will be displayed in the contour map. Save in the lower left corner saves the current image. Generally, at least 2 survey lines and at least 6 survey points for each survey line are required for the plane contour map.

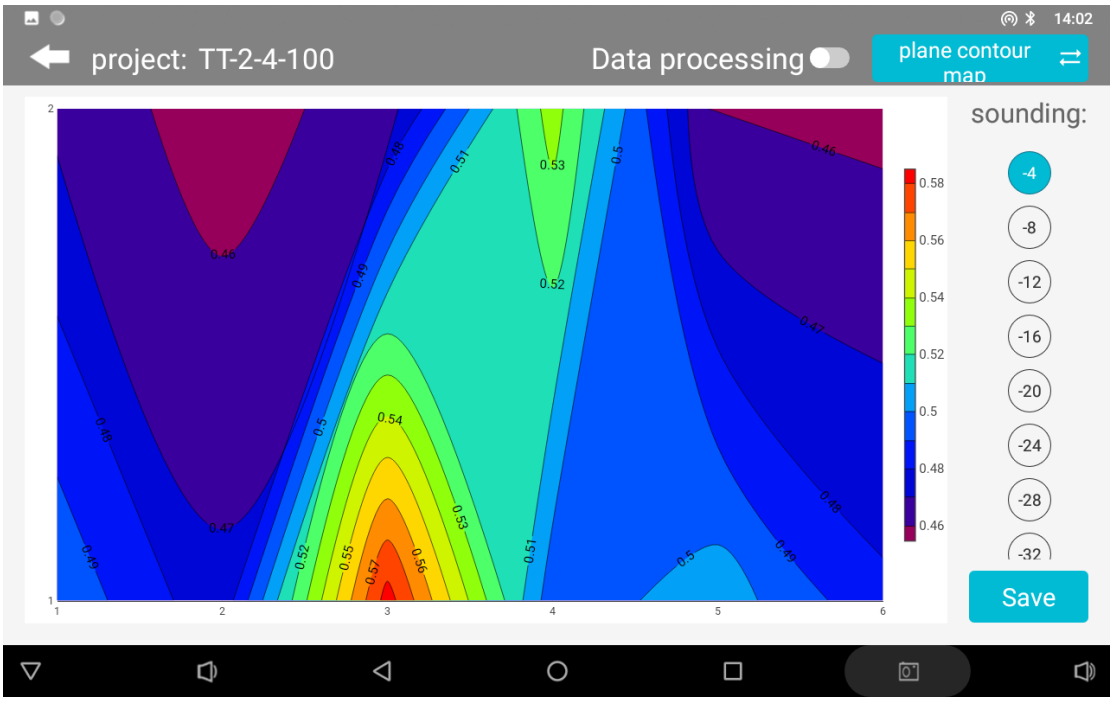


Figure 7-3

7.5 AI Automatic Analysis

After clicking "AI Analysis", the system will enter the result of AI analysis of the file data (Fig. 7-4), and the bottom will prompt "The black (red) box with the depth of XX-XX meters near the measuring point xx-xx is an abnormal area" and other prompts. This abnormal area is generally the routine abnormal judgment set by the instrument, and also the location or depth to guide you to drill. Generally, AI will prompt 1-2 areas for you to choose. You can make a comprehensive judgment and make a decision based on your experience and the actual hydrogeological environment.

At the same time, if you are not satisfied with the results, you can click the first operation icon at the bottom right of the screen to enter the AI analysis setting interface (Figure 7-5), click "Data Download" to download the latest AI analysis parameters, or click "Parameter Type" to select "Default" or "AI Recommendation". Among them, "default" is the ideal analysis parameter set for a certain type of product of the company, and "AI recommendation" is that after the AI analysis system establishes the data model according to the results of user feedback records, AI automatically learns and adjusts the generation of relevant analysis parameters, which in principle is closer to the real analysis. Of course, this needs to be determined by the accuracy of the data marked by the user himself and the number of marks.

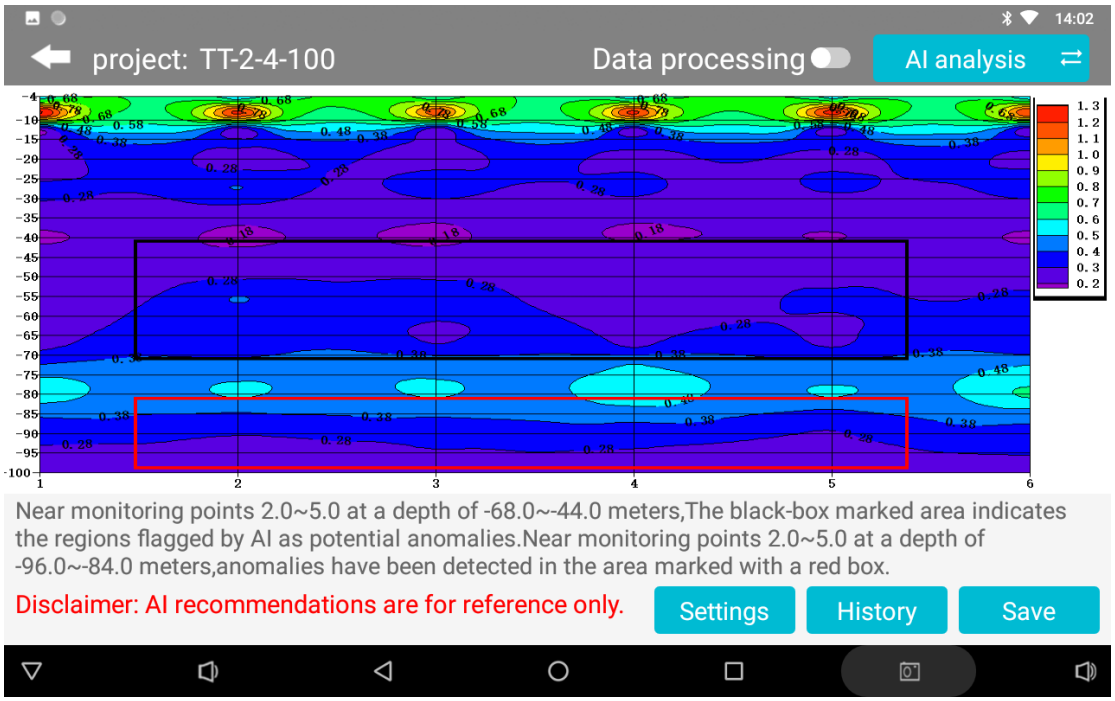


Figure 7-4

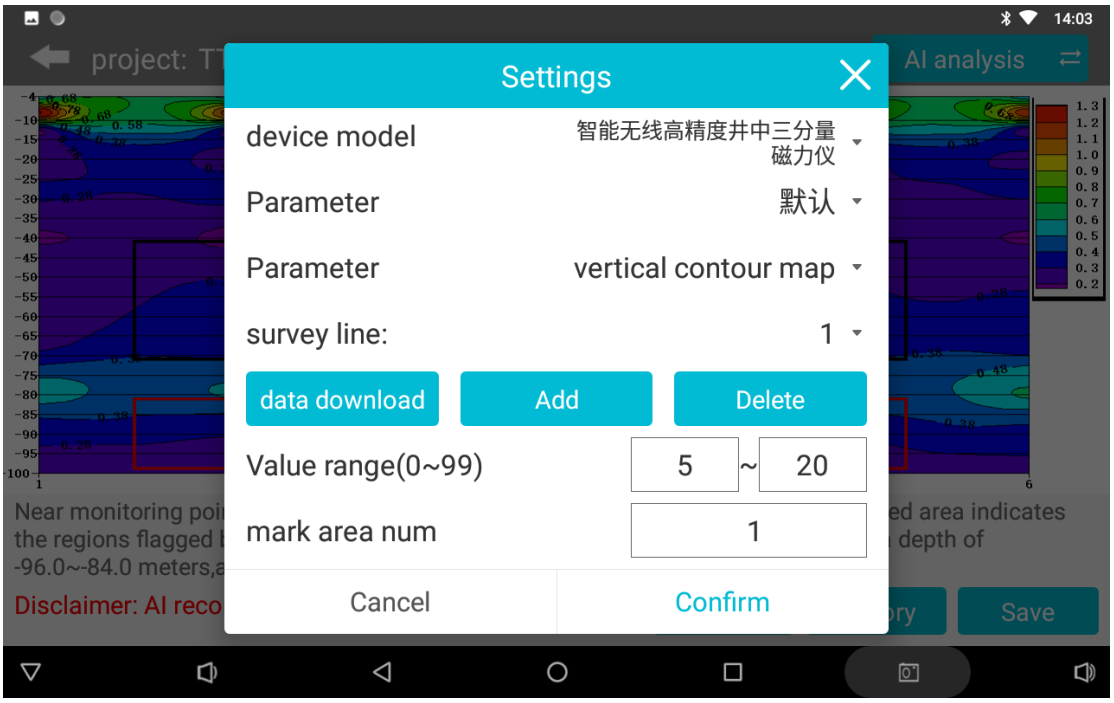


Figure 7-5

You can also select the "Add" function to manually add the AI analysis parameters belonging to your account. All our analysis algorithms have been concentrated on a percentage representation. You can manually slide the percentage of the value range left and right to adjust the AI analysis results. Generally, the smaller the percentage is, the lower the apparent resistivity will be displayed. The larger the percentage is, the higher the apparent resistivity will be displayed. It can also be an intermediate area, etc. By adjusting

this percentage, it can be displayed to the area you think is the most accurate. In this way, AI will analyze according to this setting later, which will be more accurate. You can also set the mark area to 1 so that only one optimal mark area is displayed.
This AI parameter setting generally requires very skilled use of this instrument, and has some practical experience and local data performance of this type of instrument as the basis for setting. If the primary use of this instrument, it is not recommended to use it.
Select Delete to delete this set of Set AI Analysis parameters.

7.6 Record AI analysis result feedback

AI analysis result feedback is very important, because AI is based on user feedback to machine learning, establish effective allocation rules, all AI automatic analysis is "the more accurate, the more feedback the more accurate".
In the AI analysis interface, click the second operation button at the bottom right of the screen to find the history interface (Figure 7-6). Select the "Default" button in the "Validity" column behind the analyzed data file. If the analysis result is consistent with the actual situation, click "Yes" (Figure 7-7). At this time, the system will record the valid data. AI analysis will be more and more accurate.
If not, click "No". After clicking "No", the drawing effect operation box (Figure 7-8) will pop up. The result of AI analysis can be adjusted by manually sliding the percentage range of the value range left and right. Generally, the smaller the percentage is, the lower the value area will be displayed, and the larger the percentage is, the higher the resistance area will be displayed. It can also be a certain value in the middle. Adjust the analysis result to be consistent with the actual result, and then mark it as valid, so as to increase the amount of data marked as valid. If it is not adjusted, it will not be recorded.

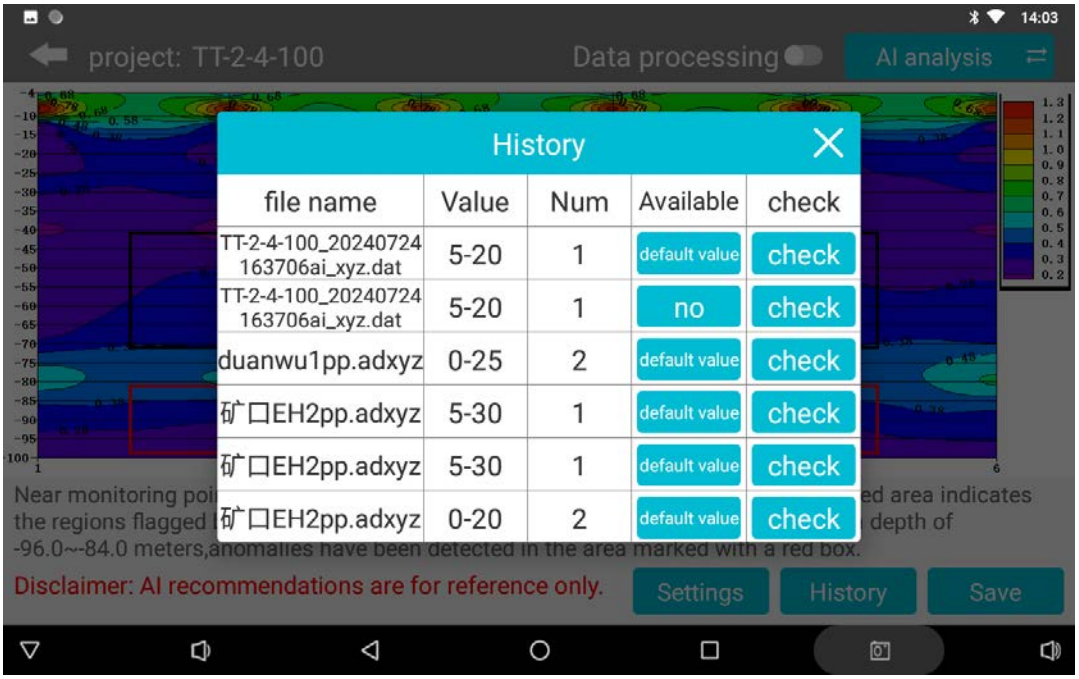


Figure 7-6

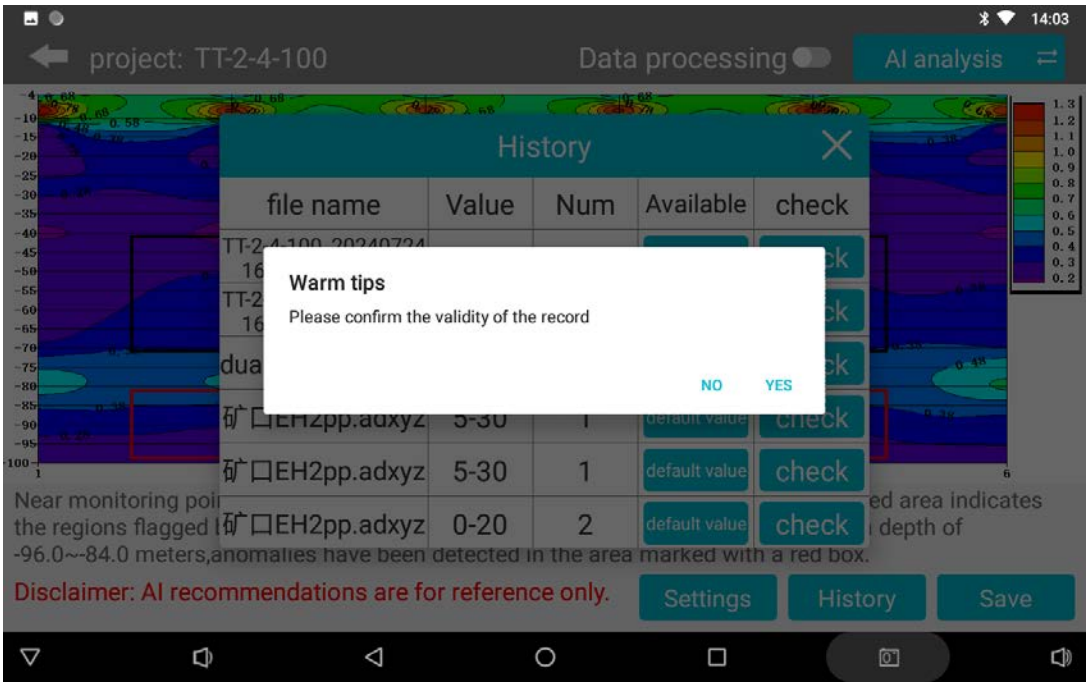


Figure 7-7

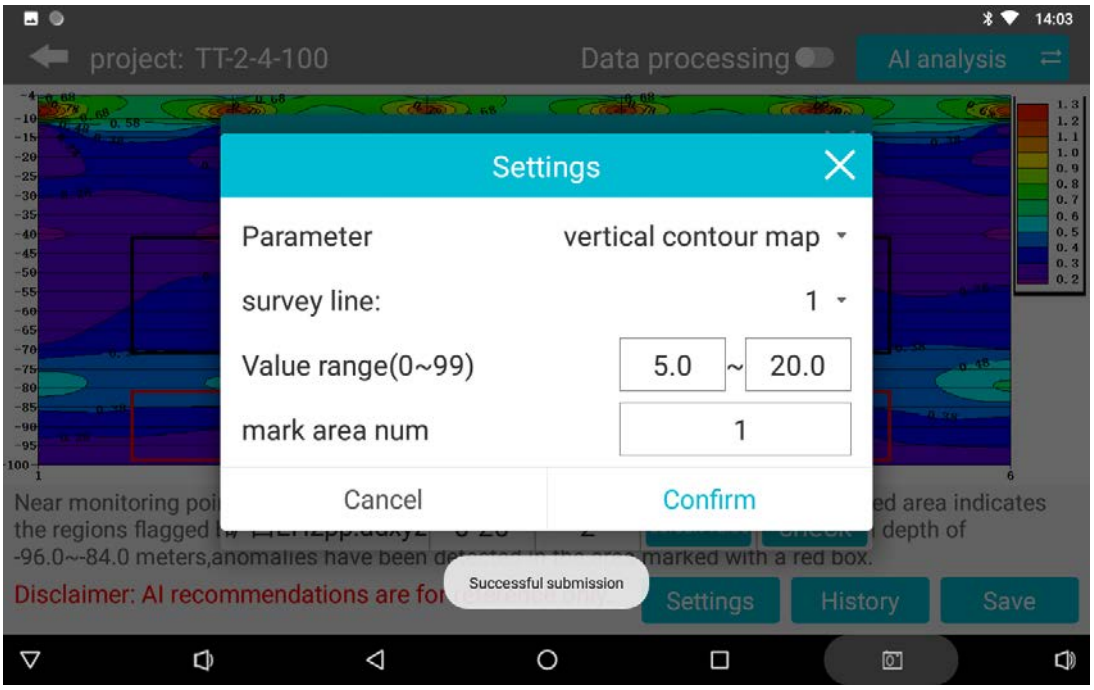


Figure 7-8

7.7 Save AI Analysis Results

In the AI analysis interface, click the third operation button at the bottom right of the screen (Figure 7-9) to save the images automatically analyzed by AI.

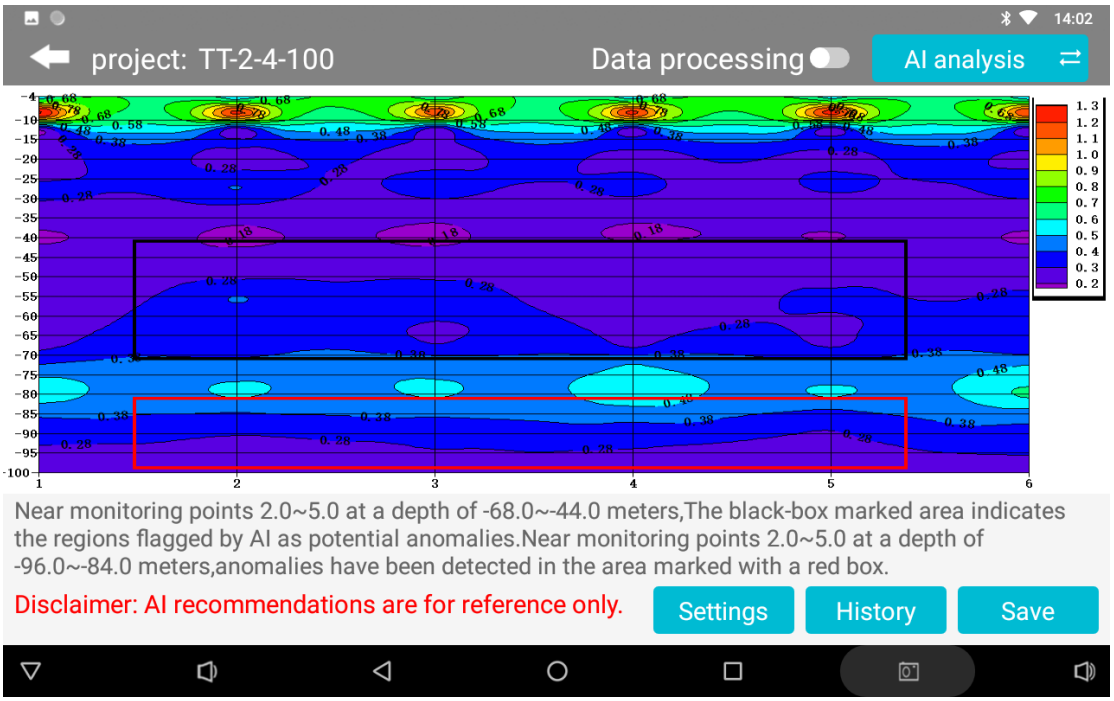


Figure 7-9

8. The field connection method

Set up the Ex and Ey channels: When starting the field setup, configure the Ex and Ey channels. Use an electrode hammer to drive the MN electrodes into the ground, with a distance of approximately 20 meters between them. Typically, bury the Hx and Hy electromagnetic sensors (probes) horizontally in the ground at a depth of 20-100cm (as shown in Figure 8-1).

Figure 8-1: Field setup diagram

During field usage, you can designate the east-west or south-north direction as the X direction, with the other direction becoming the Y direction (as shown in Figure 8-2 and Figure 8-3). After connecting the electrodes and cables, finally connect the measurement cables to the interfaces of the electromagnetic sensors and then connect them to the measurement host (as shown in Figure 8-4).

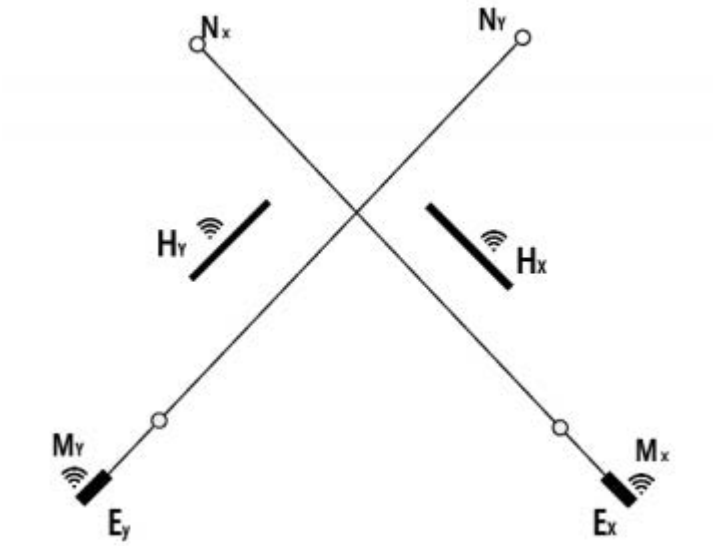


Figure 8-2: Field layout schematic

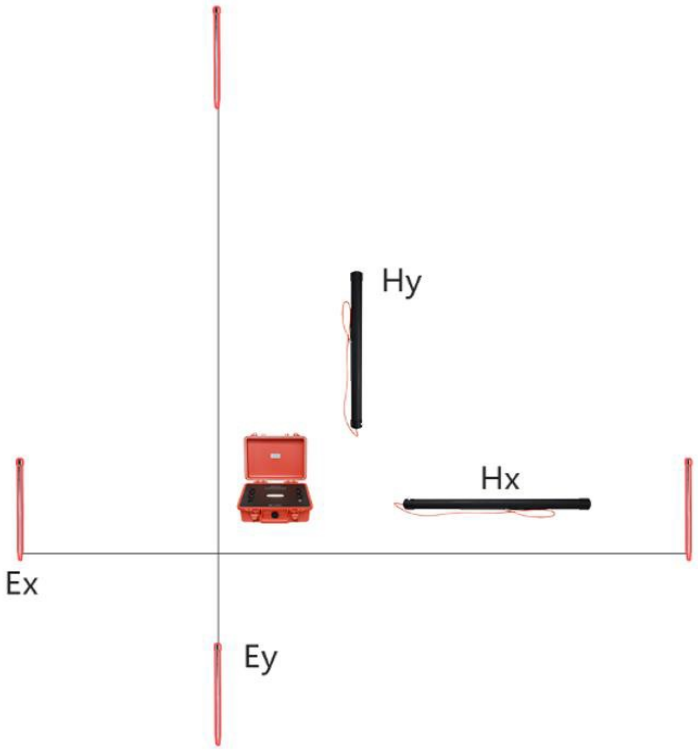


Figure 8-3: Field layout schematic(2)

Figure 8-4

9. Considerations for Using Instruments

1.Regularly check the battery level and recharge: It is important to periodically check the battery level of the equipment and ensure it is adequately charged. Maintain sufficient battery power during operation and remember to turn off the power promptly after use to prolong battery life.

2.Proper handling during transportation and use: Assign a designated person to handle and safeguard the equipment during transportation and use. Avoid subjecting the instrument to severe vibrations, impacts, or exposure to water and moisture.

3.Keep the equipment clean and store it in a well-ventilated, dry area: After each use, ensure the equipment is clean and free from debris. Store it in a well-ventilated and dry location to prevent moisture buildup or damage.

4.Pay attention to abnormal measurement data: If you encounter consistently low and similar measurement data at each measurement point, it may indicate a malfunction in the instrument. Cease using the equipment immediately and contact the after-sales support to seek confirmation and repair.

Note: The operational instructions defined in this product manual may be subject to changes due to product optimization and improvements by the company. Please refer to the latest electronic version of the manual for any updates.

大地电磁电导率仪操作手册

ADMT EH Series of Electromagnetic Conductivity Meters

上海艾都慧测智能科技有限公司

Shanghai Aidu Intelligent Detection Technology Co. Ltd

官方网址/Website: https://tk.aidush.com

服务热线/Tel: 400-902-5836