4)凸弧型滑面上滑体作破碎旋转运动，变形较明显，观测重点在滑体后缘和剪出口。

5)复合型滑面上滑体作分级分块运动，变形强烈，宜作综合观测。

5. 为定量地掌握金龙山地区滑坡的运动变形状况，并研究滑坡发展趋势、滑坡预报体系和制定滑坡防治措施，为确保二滩水电站的建设和运营安全，1987—1990 年设计并建立了一个比较完善的滑坡综合观测系统。

目前该系统已开展的 8 个观测项目是：1)滑体水平位移；2)滑体垂直位移；3)节理裂隙开闭；4)软弱结构面或滑面剪切位移；5)滑体倾斜；6)钻孔倾斜；7)地下水常规要素(水位、流量、水温等)；8)气象常规要素(降水量、气温等)。

6. 自行研制成 HP-2 型滑坡遥测系统。该系统以恒流式静态应变仪为主机，配接一位微处理器和 IBM PC/XT 或 PC-1500A 计算机。整个系统可用作分散设点集中遥测数据和测值远传，以促进滑坡研究的定量化。本系统既能控制多点巡回检测、定点检测、工作状态和通道号显示，亦能控制应变仪以半桥或全桥测量方式工作，又能控制采样时间等。1987—1990 年运行结果表明，这个系统的工作状态稳定可靠。

7. 滑坡数据库系统已初具规模。滑坡数据库系统以滑坡综合观测系统的 8 个观测项目作为 8 个子库，对各个项目所获得的数据进行综合管理，数据采集、预处理、存贮和检索、统计分析、绘制图表等的功能都很强。

8. 对滑坡预报的内容及实现途径作了探索；编制了中国(陆上)滑坡发育区划图(1∶1200 万)和滑坡事件(Ⅰ级数据库)报告单；在滑坡地表位移观测中，用 Fredericfon 法确定最佳变形场，取得满意的效果。

至 1991 年底，滑坡观测站已获得观测数据 3 万余个。获得国家实用新型发明专利的滑坡仪器 3 项：袖珍恒流式遥测应变仪，中国专利号：88212764.0；滑坡多参量管式传感器，中国专利号：88212730.6；滑坡位移传感器锁定检测器，中国专利号：88212781.0. 这些滑坡观测仪器已在国内和朝鲜民主主义人民共和国使用。

《山地研究》编辑部与本站合编的这个专辑仅反映了上列成果的一部分，下余部分容日后再找机会刊出。

本专辑中，不同的作者对有些术语的理解略有差异，本着求大同存小异的原则未予硬性统一，留待日后在实践中解决。

现有三个图件在数篇文章中是共用的，故于刊前以插页形式附之。

金龙山滑坡观测试验站　　李　沛

RESEARCH PROGRESSES OF LANDSLIDE INTEGRATED OBSERVATION IN JINLONGSHAN REGION

Jinlongshan region with 1000m to 2700m in elevation is located at Ertan, north of Panzhihua City, Sichuan Province. The key studing area of about 1.3km^2 is below 1730m in elevation. The south margent of the Jinlongshan Mountain is cutting by the Yalongjiang River. The slopes in the

region are composed of Carboniferous limestone, and claystone of Liagngshan Group, limestone of Yangxin Group and basalt of Emeishan Group of Permian System, being monoclinic-consequent ones (dipping direction of layers is 180°, dipangle of layers 35°; slope direction is 210° and slope angle about 30°).

Weather in this region is dominated by the southeastern monsoon. Annual temperature is varies from 9.5℃ to 20.5℃. Annual accumulated temperature of ≥10℃ is from 2500℃ to 7500℃, annual precipitation from 800 to 1000mm. The vertical change of natural environment is very distinct. The basic zone (below 1200m in elevation) is under the weather of south subtropical dry and hot valley. There are savanna forest and mountain brown-red soil on the valley slopes.

Jinlong Ravine partitions the dam site of the Ertan Hydropower Station off the east side of Jinlongshan region. The axis of the dam is 570m from the ravine. The Ertan dam with 240m in height is one of the largest hydropower station under construction in China. It has a capacity of 3.3MkW, and producing approximately 17GkW·h of electric energy annually. The stability of landslides in Jinlongshan region, therefore, has a direct relation with the construction and operation of the hydropower station. Owing to the importance of the landslides in Jinlongshan region to the hydropower station, therefroe, Chinese Academy of Sciences decided to establish the Jinlongshan Landslide Observation and Test Station in 1985.

The main research substances in the station include the followings: 1. basic forming conditions and triggering factors of landslides; 2. the impact on landslide stability by the infiltrated reservoir water; 3. the movement regularity and developing tendency of landslides; 4. methods and equipment of observing landslides; 5. integrated administration of landslide data by micro-computer, and landslide database; 6. control works of landslides; 7. theory and methods for predicting landslides.

In recent years, a lot of academic achievements have been obtained in the fields of basic theory, applied basic and developing research of landslide observation as indicated below:

1. In the Jinlongshan region, there exists a basic condition for development of landslide, and there are new and old, small and large landslide groups in different developing stages, of which the deep layer creeping landsliding mass with 20Mm^3 in volume in Ⅰ area has a potentical impact on safe operation of the Ertan Hydropower Station.

2. The height of the slope is more than 200m, and the average slope angle is between 30° to 15° when a yield-break (buckling) landslide might occur in the strate of anacline bedded slopes. The ratio of main sliding section to resisting sliding section is 2.5 to 1.0 generally. The sliding surface will be transformed from surfacial layer to inside of the slope with the upheaval of layered rocks one by one, finally the sliding mass might shear out at the maximum vector high point, and thus to create a consequent rock landslide.

3. The σ_3-effect in the slope evolution prosses: 1) As the ratio (<1:200) of the thickness to the length of the layered rocks reaches to an ultimate value in the surfacial rocks of dip bedded slopes, a yield bending will take place under the combined actions of the component of gravity

(maximum principal stresss σ_1) of the upper section of the rock and the expansive stress (least principal stres σ_3), which makes th layered rock move upwards. Gradually, the yield bending will develop into a type of buckling landslide. 2) For the slopes composed of clay or soft rocks horizontally bedded, a small rock mass in a surfacial place of the slope can be squeered freely out towards free slope surface under the sufficient pressure of the overlying rock, in this case, $\sigma_3=0$. In the inside of the slope, the rock mass is not likely to expand freely due to resistance of surrounding rock pressure, $\sigma_3\neq 0$, thus a stress gradient (σ_3 gradient) is created, clay or soft rock will be squeered from outside of the slope, the overlying rock will move out like a boat to become an expansive block landslide.

4. Landslide observing system is set up on the basis of the moving deformation features of landslide. The moving deformations are controlled by the type of sliding surface. They are various for different sliding surface, thus, the measuring points, methods and equipment are also quity different.

5. In Jinlongshan region, for quantitative mastering movement requlority, sliding tendecy and prediction, and also for supplying academic basis of control methods, an integrated observing system of landslide had been designed and set up during 1987 to 1990. 8 observing items have being undertaken. They are: 1) horizontal displacement of sliding mass; 2) vertical displacement of sliding mass; 3) spreading and closing of joints and craces; 4) shearing displacement of weak structural surface and sliding surface; 5) dipping of sliding mass; 6) dippin of borehole; 7) conventional elements of ground water (level, discharge, temperature of water); 8) conventional weather elements.

6. A HP-2 landslide remote-indicating system composed of a selfproduced, static constant current strainmeter, as a key part, and combining with an IBM PC/XT or PC-1500A computer can make multiple points rounding and in-site measurements in the ways of half and whole bridges. The measuring data obtained are storaged and administered by micro-computer. If the data obtained over the critical volume pre-designed, the equipment will make a warning signal. The operative experiences made during 1987 to 1990 indicated that the system is stable and believable.

7. A database system of landslides has been established, the function of the database is to make a integrated administration of the data obtained form the varied observing items based on the 8 observing items mentioned above as 8 sub-database.

8. Landslide prediction and the methods of prediction have been studied, and a sketch map of China showing development zonation of landslide and a report list of large landslide events I class database) have been completed.

9. Up to now, the station has obtained more than 30,000 data. 3 instruments selfproduced for observing landslide have been patented as Chinese new applied inventions.

Jinlongshan Landslide Observation and Test Station **Li Pei**