十七、83 道班移动冰丘及灾害效应

在青藏公路 83 道班东侧，青藏铁路以大桥通过二道盆南活动断裂，部分桥墩设置在断裂破碎带；桥基施工诱发上涌泉水，冬季产生厚层冰幔和移动冰丘，命名为 83 道班移动冰丘。在 2002 年 1-2 月铁路大桥施工前，青藏公路 83 道班东侧沿二道盆南活动断裂虽然发育冲沟、溪流、冰丘和冰幔，但冰幔和冰丘的规模较小，在设计铁路大桥附近不存在厚大冰层和较大冰丘。在 2002-2003 年铁路大桥建设期间，部分桥墩建于二道盆南断裂破碎带，桥墩地下基础工程施工深入地下≥10 米深度，穿透断裂破碎带的富水构造和地下水通道，诱发大流量上涌泉水，冬季形成厚度≥50cm 的大面积地表冰层，沿部分桥墩冬季形成高达 2.5m 的较大移动冰丘（吴珍汉等，2004，2005）。2004 年 3 月，已经部分消融的冰丘锥顶尚抵达路轨下方的横梁，冬季最寒冷时期的冰丘锥顶可能抵达并顶托路轨；部分墩台由于地下冰层的冻胀和顶托作用，发生透入性横向破裂，影响墩台的工程质量。但 2004 年夏季铁路建成通车后，运料列车通过 83 道班东侧铁路大桥，导致断裂破碎带桥基震动，阻断了泉水上涌通道，大幅度减小了断裂破碎带桥墩周围的上涌泉水流量，起到了消除了断裂破碎带桥基施工诱发地质灾害隐患的效果。

PART 17 83RD STATION MIGRATING PINGO AND ITS HAZARD EFFECTS

Some bridge piers were constructed in fault zone in east of the 83rd station of the Highway in south of Erdaogou basin. No pingos formed along railway line before the construction bridge piers in early 2002. However, construction of bridge piers in fault zone lead to large volume of upward rushing spring water in summer and autumn of 2003, which resulted in thick ice sheet and big, high migrating pingo in the coming winter, i.e. the 83rd station migrating pingo. Ice sheet was as thick as 50cm and migrating pingo is as high as 2.5m, reaching to cross beam beneath rails in March of 2004. In cold winter top of the pingo must have been higher and seriously threatened the safety of railway. Fortunately, running train across the railway bridge resulted in pier vibration in fault zone which closed pathway of underground water in breccia, leading to sharply decrease of upward rushing spring water beneath railway bridge in east of 83rd station. Such process evidently reduced geological hazards of the 83rd station migrating pingo.

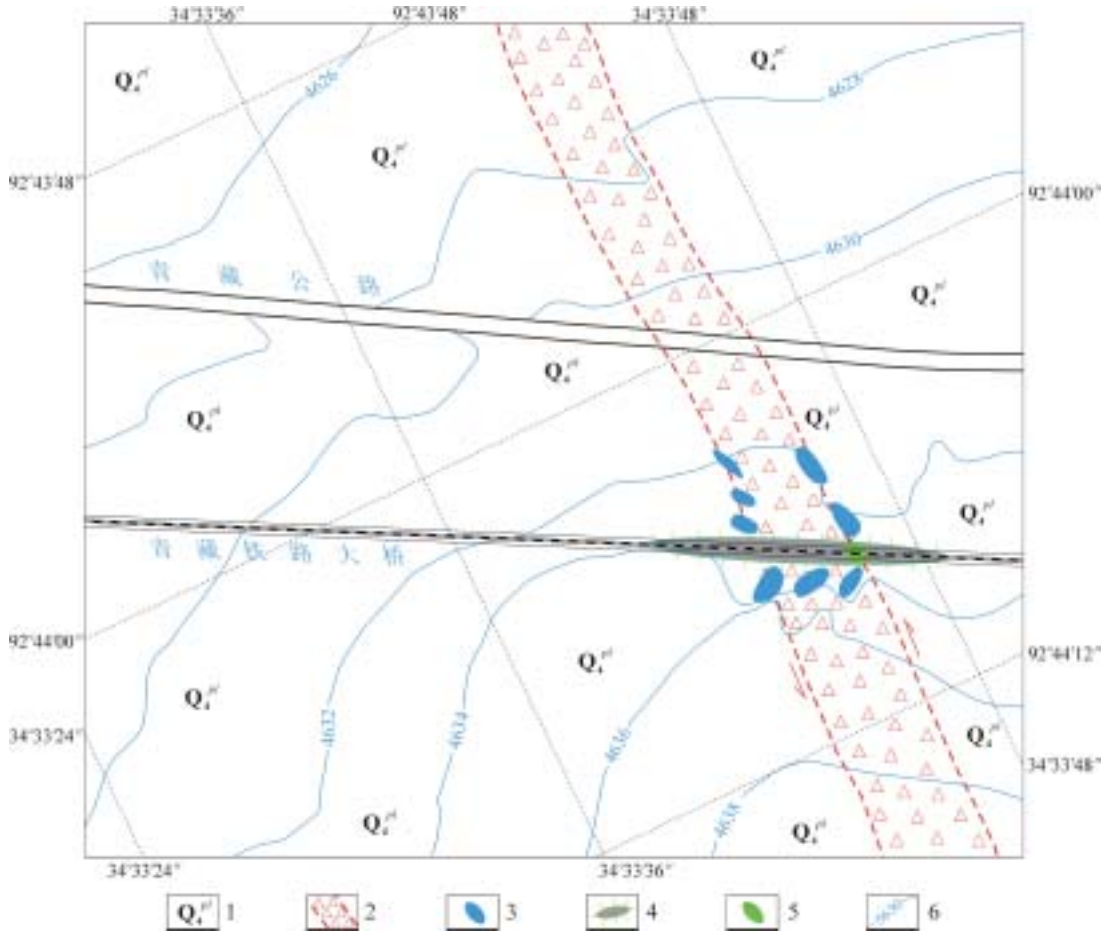


图 213 青藏公路 83 道班平面地质图

图例说明：1-全新世冲积物；2-隐伏断裂破碎带；3-2002 年 2 月冰丘；4-2004 年 3 月厚层冰幔；5-2004 年 3 月移动冰丘；6-等高线（m）

Fig.213 Quaternary geological map of 83rd station of the Highway. Explanation: 1-Holocene fluvial deposits; 2-buried fault breccia; 3-pingos appeared in February of 2002; 4-thick ice sheet in March of 2004; 5-migrating pingo in March of 2003; 6-elevation contour (m)



图 214 铁路桥梁施工前 2002 年 2 月 83 道班东侧仅发育小规模的薄层冰幔

（镜头向东，摄于 2002 年 2 月）

Fig.214 View eastward in February of 2002 at freezing fault valley in east of 83rd station of the Highway before the construction of railway bridge



图 215 83 道班断裂破碎带桥基施工诱发大流量涌泉水冬季冻结形成大规模厚层冰幔

（镜头向南，摄于 2004 年 3 月）

Fig.215 View southward in March of 2004 at thick ice sheet resulted from freezing spring water induced by construction of piers in fault breccia



图 216 83 道班断裂破碎带桥基施工诱发高 2.5m 的较大规模移动冰丘

（镜头向南，摄于 2004 年 3 月）

Fig.216 View southward in March of 2003 at migrating pingo of 2.5m high in east of 83rd station of the Highway induced by underground construction of railway bridge piers in fault breccia



图 217 83 道班断裂破碎带桥基施工诱发冰幔及不均匀冻胀导致承台破裂

（镜头向东，摄于 2004 年 3 月）

Fig.217 View eastward in March of 2004 at fracture across base beam connecting bridge piers by freezing expansion of ice sheet induced by underground construction of railway bridge



图 218 83 道班横穿断裂破碎带的铁路桥梁铺轨后机车震动阻断泉水上涌未形成泉坑

（铁路铺轨运料车通行后，泉水流量较 2004 年 3 月通车前明显减少；镜头向南东，摄于 2004 年 7 月）

Fig.218 View southeastward in July of 2004 at dry fault valley after completely thawing of ice sheet and evidently decrease of spring water blocked by train vibration



图 219 83 道班横穿断裂破碎带的铁路桥梁铺轨后机车桥基震动阻断泉水上涌

冬季移动冰丘消融后，夏季泉水由于铁路机车震动阻断泉水通道，上涌泉水流量显著减少；镜头向东，摄于 2004 年 7 月。

Fig.219 View eastward in July of 2004 at evidently decreased upward rushing spring water which was blocked by train vibration