

柴达木盆地北缘反转构造特征及其控煤作用分析

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摘要:基于构造与煤层赋存状态的关系,为进一步认识柴达木盆地北缘反转构造的控煤作用,依据反转构造识别原则,对柴达木盆地北缘各构造分区中典型煤矿区的地质剖面进行反转构造识别,并利用平衡剖面技术,探讨反转构造演化过程的控煤作用。结果表明:①研究柴达木盆地北缘普遍认识到该区在晚侏罗世-白垩纪发生过正反转构造,但是缺乏地质工作程度较高的煤矿区研究实例和控煤作用的分析;②通过对选取的地质控制程度较高的地质剖面进行反转构造识别,将各构造分区的构造反转时限进一步厘定晚侏罗世;③反转构造的控煤作用在反转前后均有有利条件,反转前为成煤作用提供可容空间,反转后使得发育较好煤系及煤层的上盘变浅。

关键词:柴达木盆地北缘;反转构造;控煤作用;煤系

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Analysis on inversion structures characteristics and coal control action in north margin of Qaidam Basin

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Abstract: According to close relationship existed between structure and coal seam occurrence state in North Qaidam Basin, in order to further understanding the coal controlling of inversion structures, based on the principle of inversion structures, the inversion structure of the geological sections were identified in typical coal mine areas of different tectonic divisions in North Qaidam Basin by using balanced section technology, the coal controlling in the evolution process of inversion structure was also discussed briefly. The results showed that it was widely recognized by researchers that the study area occurred positive inversion structure during the late Jurassic and Cretaceous period, and the research was in short of samples for coal mines with adequate geological research and relevant analysis on the function of coal controlling. Through identifying the inversion structure on selected geological sections with high geological control degree, the time limit for inversion of each tectonic partition was further determined as late Jurassic epoch. The coal controlling can provide space for the function of coal forming before the inversion of structures, and also can make the good coal measures and the hanging wall of coal seam become shallow after inversion.

Key words: north margin of Qaidam Basin; inversion structure; coal-controlling function; coal measures

0 引言

反转构造是指同一断裂面出现2期力学性质和

运动方向都相反的构造组合。按照反转构造作用大小分为断层的反转、盆地的反转及盆地系的反转^[1]。断层的反转又可以分为正反转断层和负反

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转断层,先正后逆的称为正反转,相反情况称为负反转。相对应的地质过程前者为先伸展后挤压,后者为先挤压后伸展。目前,我国反转构造研究在油气盆地和造山带领域得到广泛的关注和重视。同样,在我国东北、华北、西南地区含煤盆地中确定存在反转构造组合^[2-4]。而包括柴达木盆地北缘(简称柴北缘)在内的西北地区随着研究的深入,越来越多学者认识到该地区构造发生过正反转。将柴北缘作为研究对象的学者^[7-11]应用不同方法得出构造反转发生在晚侏罗世-白垩纪;在西部分区开展构造研究的认为构造反转时期较长,具体时期为晚侏罗世或白垩纪至古近纪^[12-13],原因是邻近的柴达木盆地西部地区发生的二次构造反转^[14-15],在西部分区合并为一次;在中部构造分区开展的的研究人员中,易红霞等^[16]对中部构造分区确定的构造反转时限与研究柴北缘学者认识基本一致;狄恒恕等^[17]认为红山地区构造反转发生在白垩纪之后;研究青海东部构造分区的,大部分与区域研究人员认识一致^[18-21],部分学者^[22-23]将其精确至白垩纪。上述研究柴北缘中生代构造演化过程中,虽然认识到发生过构造反转,但均针对油气区块,通过地震剖面

识别、实验室砂箱模拟、磷灰石裂变径迹分析、有机地球化学数据统计等方法,缺乏地质工作程度较高的煤矿区研究实例。所以,笔者研究利用自身优势,选取各个构造分区地质工作程度较高的煤矿区典型地质剖面,依据正反转断层的上下盘同层位地层厚度差异与现今断层位移方式相矛盾,以及现今逆断层上盘地层赋存深度比下盘大的反常现象,识别出反转构造,探讨其控煤作用,为相关研究人员提供一定的参考价值。

1 柴北缘地层概况

柴北缘为一北西向条带,西窄东宽,地形为隆凹相间的格局(图1)。隆起区大部为老山出露,凹陷区大部为新生代地层覆盖。凹陷区的中、新生代地层分布单元与基底岩性有很好的对应的关系^[24]。含煤地层为侏罗系下统小煤沟组、中统的大煤沟组和石门沟组,以及石炭系上统扎布萨尕秀组。目前发现侏罗系的基底有古元古界的花岗片麻岩、奥陶系滩间山群绿泥片岩和寒武系、震旦系的大理岩组成,石炭系上统克鲁克组的基底为其整合接触的克鲁克组。

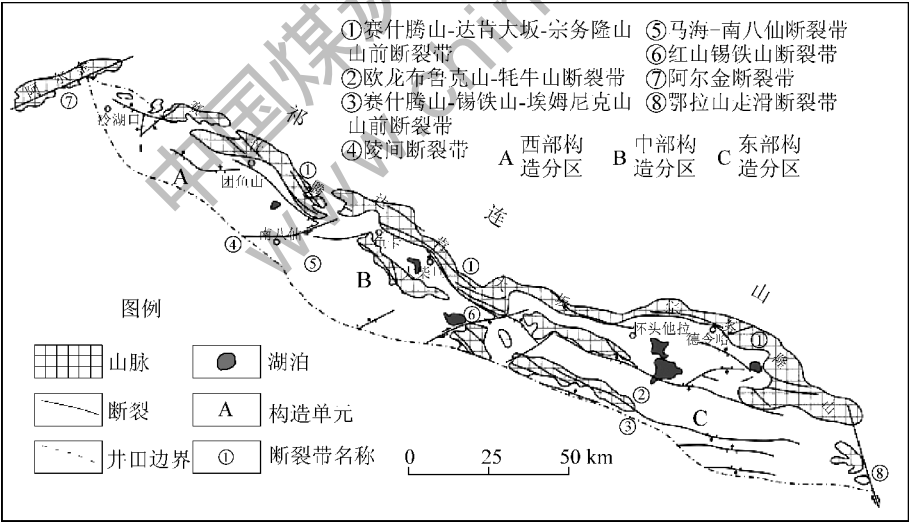


图1 柴北缘煤田构造纲要图

Fig. 1 Tectonic outline of north margin of Qaidam Basin Coalfield^[25]

2 柴北缘构造特征

柴北缘处于柴达木盆地北部祁连构造体系北部冲断带^[26],划分为2个带:属于柴达木盆地二级构造单元,由逆冲推覆构造带和前陆滑脱拆离带^[27-28]2个带,西部构造分区、东部构造分区和东部构造分区^[25]3个区组成(图1)。其总体呈北

西—南东向展布,四周为主干断裂所围限,与周围构造单元分割^[29]。经多期构造作用叠加,现今断裂为旧并复合的结果,主体断裂系统为北西西向,由西向东呈扫帚状,局部为反“S”型,并且被北东向压扭性平移逆断层错断。断裂相夹断块或呈单斜构造形态或呈不完整的褶皱构造形态。虽然现今所表现的变形样式主要为收缩式逆冲断层和褶皱构造,但无

论在盖层和基底内都可找到中生代古构造所残留下的正断层,说明在中生代、新生代构造演化过程是伸展和挤压交替进行的,而并非长期挤压收缩的单一构造体制^[30-31]。

3 典型煤矿区反转构造特征及控煤作用

3.1 团鱼山地区

该区位于西部构造分区的赛什腾山南缘,区内煤炭工作程度均达到勘探。该区发育与区域构造线基本一致的北西西向逆冲断层,受该系列断层影响,形成北西—南东向3个断块,北部和南部断块为南倾的单斜构造,中部为不完整向斜构造。选取分析的剖面为贯穿2个勘探区的典型剖面(图2a)。剖面图中明

显具有正反转断层特征的是F5断层和F8断层,确定F5为正反转断层的依据如下:F5断层现今表现为南西倾的逆断层,剖面图中该断层左侧即断层上盘施工的钻孔钻遇中侏罗统石门沟组部分地层真厚为221.93 m,预计上盘该套地层真厚为302 m;而下盘由多个钻孔控制,该套地层平均厚度约200 m,即中侏罗统石门沟组在F5逆断层上盘的明显比断层下盘厚,与现今表现为逆断层的位移方向矛盾。同理,现今为逆断层的F8断层确定为正反转断层的依据为断层上盘为新近系中新统干柴沟组,下盘为较老的古近系渐新统干柴沟组,与发生一次运动情况下,逆断层上盘老地层压盘新地层不符,所以该断层明显发生2次构造运动:先正后逆的正反转。

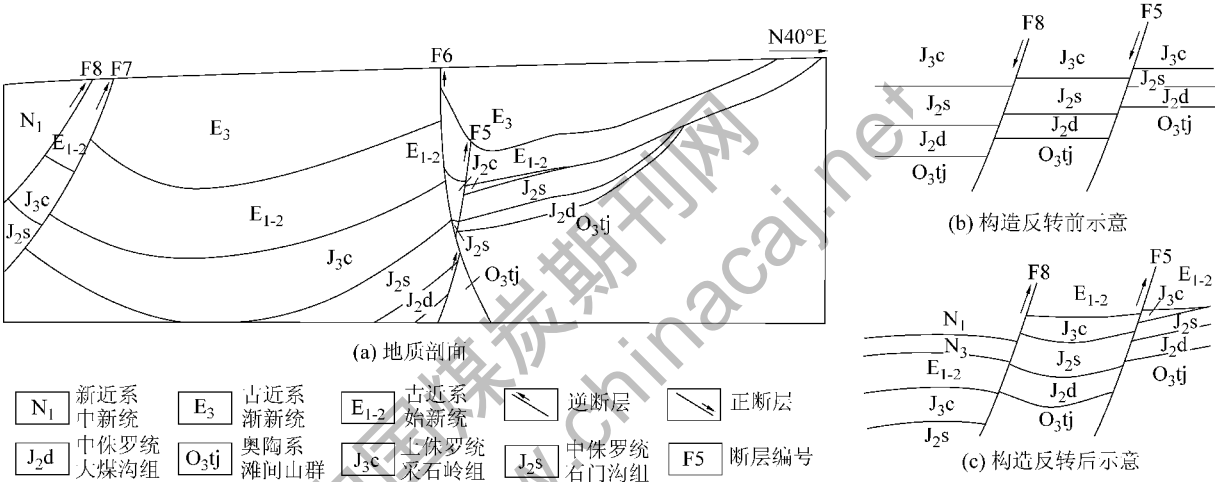


图2 团鱼山地区地质剖面及反转构造形成过程

Fig.2 Geological profile in Tuanyushan Area and evolution history of inversion

通过对剖面反演,该地区中生代以来经历5个阶段:①晚侏罗世之前,受拉张作用影响,该地区形成由北往南逐步加深的3个阶梯状断块,断层上盘下降提供了有利的成煤空间,沉积了煤系(中侏罗统大煤沟组和石门沟组),发育7层煤,地层由北往南变厚;②晚侏罗世,由拉张作用过渡到挤压作用,形成平缓的向斜式基底,沉积了中间厚两翼薄的晚侏罗世采石岭组;③进入白垩纪后,该地区整体隆升,造成晚侏罗世红水沟组和白垩纪地层无残余,该阶段断层上盘上升,但其系赋存深度仍比下盘较深,导致上盘煤系未遭剥蚀,断层下盘煤系遭受剥蚀;④古近纪至新近纪,该地区整体下降,古近系与侏罗系和奥陶系不整合沉积,且随着挤压作用更加强,沉积,中生代形成的F6断层被新生代形成的F5断层切割,之前形成的向斜两翼地层倾角会变陡峭;⑤第四纪,该地区整体隆升,仅在局部地区沉积第四系。

据此分析,团鱼山地区在中生代以来,在演化的第2个阶段发生过一次构造反转,反转期为晚侏罗世早期,典型的反转断裂有F5和F8断层其控煤作用在构造反转前后均为有利条件,反转前为成煤作用提供空间,反转后使得良好的煤层赋存深度变浅。

3.2 全吉山地区

该区位于柴北缘中东部构造分区,北以达肯大坂-欧龙布鲁克山为界,南以锡铁山为界,西至绿梁山,东至埃姆尼克山。区内不同区块均开展过煤炭勘查工作和非常规能源调查评价工作,电法、重力、地震工作全覆盖,研究程度较高。该地区发育2组断裂,第1组为北西、北西西向逆冲断裂,第2组为切割第一组断裂的具压扭性的北东向的逆冲断裂。受2组断裂控制,呈南北向条带状菱形断块,断块为单斜或向背斜构造。选取分析的剖面为贯穿全吉山煤炭整装勘查区科研项目编绘的倾向剖面(图3a)。

剖面图中本应存在多条正反转断层,但由于后期构造改造后残留部分虽然在地震剖面有反应,但缺乏钻探工程的控制。目前,明显具有正反转断层特征的是F3断层,现今表现为北东倾的逆断层,断层上

盘为该地区的红山向斜构造单元,由于赋存深度均大于1 500 m,仅有石油钻孔控制中侏罗统真厚约767 m。下盘为西大滩煤炭勘探区,该区块中侏罗统平均厚度292.57 m。

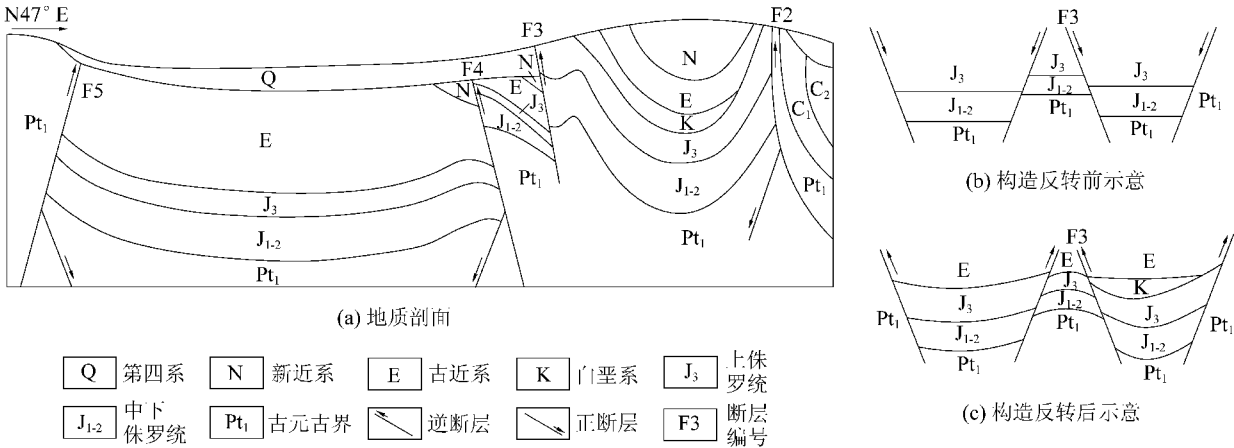


图3 全吉山地区地质剖面及反转构造形成过程

Fig. 3 Geological profile in Qianjishan area and evolution history of inversion

通过对剖面进行反演,该地区中生代以来经历4个阶段:①晚侏罗世之前,受拉张作用影响,该地区形成多个断块并进行差异性沉降,在低位沉积早侏罗统小煤沟组和中侏罗统大煤沟组和石门沟组,发育7层煤;②晚侏罗世-白垩纪,构造作用为挤压,由之前的断陷转为坳陷,大部分地区遭受剥蚀,晚侏罗世上部地层红水沟组在区内普遍缺失,仅在局部地区沉积白垩纪地层;③古近纪,盆地整体下降,古近纪地层不整合与之前时代的地层,且随着挤压作用进一步加强,沉积,中生代形成的F5断层被切割形成新的断层F6,之前形成的向斜两翼地层倾角进一步变陡峭;④第四纪,区域挤压作用进一步加强,之前中生代的部分断层被切割破坏,区域整体隆升,在沟谷地带沉积第四系。据此分析,全吉山地区在中生代以来,在演化的第2个阶段发生构造反转作用,由于白垩系不整合于上侏罗统采石岭组,可以确定反转期在此之前已结束,即反转期为晚侏罗世早期,可识别的反转断裂F3断层上盘虽然沉积较厚的煤系但煤层发育不如下盘,且区内的主要控煤构造为新生代以来形成的断层对其进行切割剖坏,所以该地区反转构造的控煤作用不明显。

3.3 旺尔秀地区

旺尔秀地区位于柴北缘东部构造分区的乌兰凹陷内,南为巴音山,东为扎布萨尕秀上,区内煤矿点均达到勘探,外围开展过不同程度的煤炭勘查工作。

该地区发育2种类型断层,一种与区域构造线类似的北西向逆冲断层,另一种为北东向逆断层。选取分析的剖面包括区内的旺尔秀煤矿的一个工区和外围普查区的剖面(图4a)。剖面中具有正反转构造特征的是F2断层。首先该断层在地表露头上反映为逆断层,但是断层上盘地层的赋存深度比下盘的要大,说明该断层前期正断层,后期才转为逆断层的。再者,断层的上盘经钻孔揭露,在断层两侧均沉积了完整层序的中侏罗统石门沟组,但该套地层厚度在上盘经1个钻孔揭露约221 m,下盘经煤矿区及其外围多个钻孔揭露厚度平均厚度约144 m,进一步佐证了该断层为正反转断层。

通过对剖面反演,该地区中生代以来经历4个阶段:①晚侏罗世之前,受拉张作用影响,该地区形成多个断块并进行差异性沉降,在低洼地带沉积中侏罗统石门沟组,发育3层煤;②进入晚侏罗世后,构造作用逐渐转为挤压,由之前的断陷转为坳陷,未沉积晚侏罗世早期的采石岭组,而是沉积了后期的红水沟组;③白垩纪古近纪,随着柴达木盆地整体下降,白垩纪-古近纪地层不整合于侏罗系;④古近纪至今,区域整体隆升,各时代地层遭受不同程度的剥蚀,造成古近系和新近系在该没有残余。所以该地区自中生代以来,发生过一次构造反转,反转期为晚侏罗世早期,可识别的反转断裂F2断层控煤作用与团鱼山地区的反转构造类似,均为有利条件。

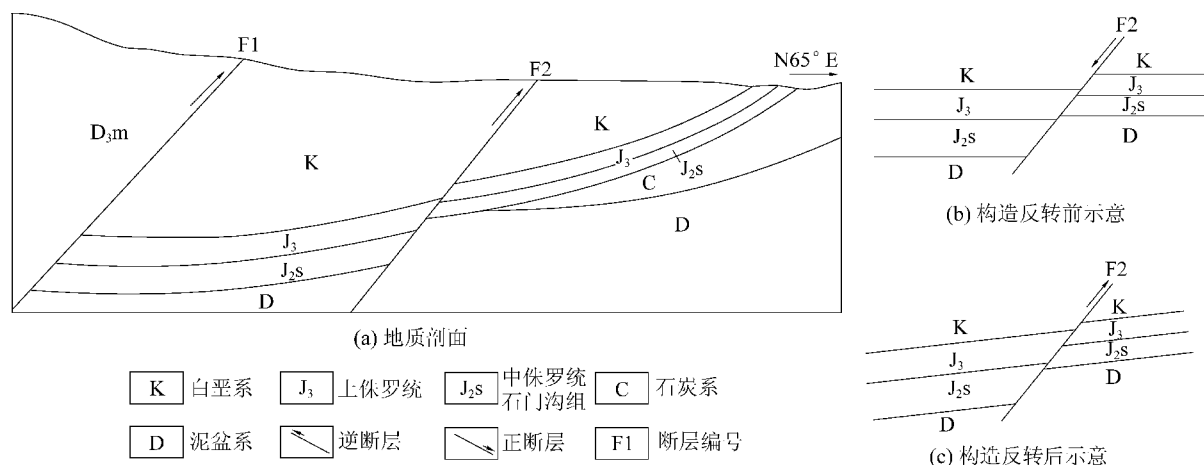


图 4 旺尔秀地区地质剖面及反转构造形成过程

Fig. 4 Geological profile in Wanggaxiu Area and evolution history of inversion

根据以上分析结果,得出柴北缘地区在各构造分区的构造反转时期基本一致,初步呈现由西向东逐步变早的趋势。

4 结 论

1) 中生代-新生代期间,柴北缘发生构造反转的认识基本统一,大部分学者认为构造反转时期为晚侏罗世-白垩纪。

2) 本次研究选取柴北缘各构造分区地质工作程度较高的典型煤矿区, 分析其反转构造特征, 进一步得出各地区的构造反转均在晚侏罗世发生。

3)柴北缘地区反转构造的控煤作用在反转前后均为有利条件,反转前为成煤作用提供可容空间,反转后使得发育较好煤系及煤层的上盘变浅,适宜近期开展生产和勘探。

4) 柴北缘地区构造复杂,本次研究仅通过选取各构造分区的典型构造剖面,对研究区的构造不能面面俱到,所以可能有很多反转构造未被发现,且以往煤炭地质勘查工作中对其不够重视,建议今后加强研究,正确认识此类控煤构造,以便更好地指导煤炭勘探和生产工作。

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